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VOLUME XVIII. SAN FRANCISCO, CAL., APRIL 13, 1907 No. 15

The Economy of Electric Power in Quartz Mining.*

By C. O. POOLE

The subject matter of this paper has been largely obtained from the practice of the mines on the Mother Lode in Amador and Calaveras counties, California. This paper is not intended as a scientific treatise of the subject, but its object is to present in a practical way the economical results obtained by the use of electric power in comparison with steam power, using wood, coal and oil as fuel.

For more than fifty years the monotonous rumble of the stamp mills has echoed and re-echoed among the hills in the vicinity of Amador and Sutter Creek, and they seem destined to rumble for another fifty years, thus completing a century of echoes and prosperity throughout the community. Recent developments have demonstrated that almost inexhaustible bodies of ore lie far below the surface of the ground. Old mines that were thought to have been worked out, and were abandoned and left idle for a quarter of a century, have within the past few years been reopened, and their owners, by sinking deeper into the ground, were rewarded by striking large bodies of pay ore that insure a profitable return for many years to come.

The ore encountered in this locality is of low grade, ranging from $2.50 to $6.00 per ton; hence, in order to work a mine profitably under these conditions, it must be well managed. The mine superintendent must be a very versatile man; he must have good business judgment, and he must be scientific, mechanical, practical and economical. You must not be surprised, then, upon approaching him with a proposition to equip his mine with electric power, if your stereotyped arguments are received with a kind but pitying smile, and you in turn receive a very valuable lecture on power for mines. If, however, you are able to convince him that your proposition has merit, and a saving in cost of operation can be effected by its adoption, he will enter into the scheme with you, and better treatment than you will receive at his hands could not be asked for. Until quite recently the source of power at these mines has been steam and water power. The water wheels are working under heads varying from 160 feet to 520 feet. Water power under the last named head, at the prices now charged there, is about equivalent in cost to electric power at $6.50 per horsepower per month. On heads lower than this, however, it is obvious that material savings can be made, hence, water wheels in this locality are rapidly becoming a thing of the past.

The uses of water at a mine are somewhat varied, and in applying electric power, each case is a study by itself. The principal uses consist in driving stamps, concentrators, air compressors, sawmills, blowers, pumps and hoists. It is the hoist that I particularly wish to dwell upon. The conclusions that I draw in this connection may differ widely from the ideas of many, but I am, nevertheless, firm in my convictions.

A GENERAL VIEW OF THE ONEIDA MINE IN AMADOR COUNTY.

The fuel used for steaming purposes is principally wood and fuel oil. Coal has been used, but not to any great extent. The competitors to electric power are, therefore, wood and oil. If there is one mistake that a mine superintendent makes, it is in estimating the amount of power that he is using. He invariably over-estimates the actual horsepower consumed and owing to the intermittent character of the work (except that of the mill), it is very difficult to accurately estimate the power developed by a steam engine used in mining duty. If, then, you are told that he is making a horsepower for $8.00 or $10.00 per month with wood, don't be discouraged, for in obtaining these figures he may have divided his fuel bill by the rating of

*Reprinted by request from the July, 1902, number of the Journal of Electricity, Power and Gas.

a 100 horsepower engine, when the average power developed was less than fifty horsepower.

In order to demonstrate what can be done with steam power, let us enter into a few figures:

Wood.

A cord of dry pine wood (which is the variety of wood used in this section), weighs approximately 2,000 pounds, and its contents measure 128 cubic feet, of which about 56 per cent. is in wood and 44 per cent. is in spaces.

The composition of average air-dried wood, which carries 5000 British thermal units (B. T. U.) per pound, is as follows:

Carbon	37.50	per cent
Hydrogen	4.50	"
Oxygen	30.75	"
Nitrogen	.75	"
Ash	1.50	"
Hygrometric water	25.00	"
	100.00	per cent

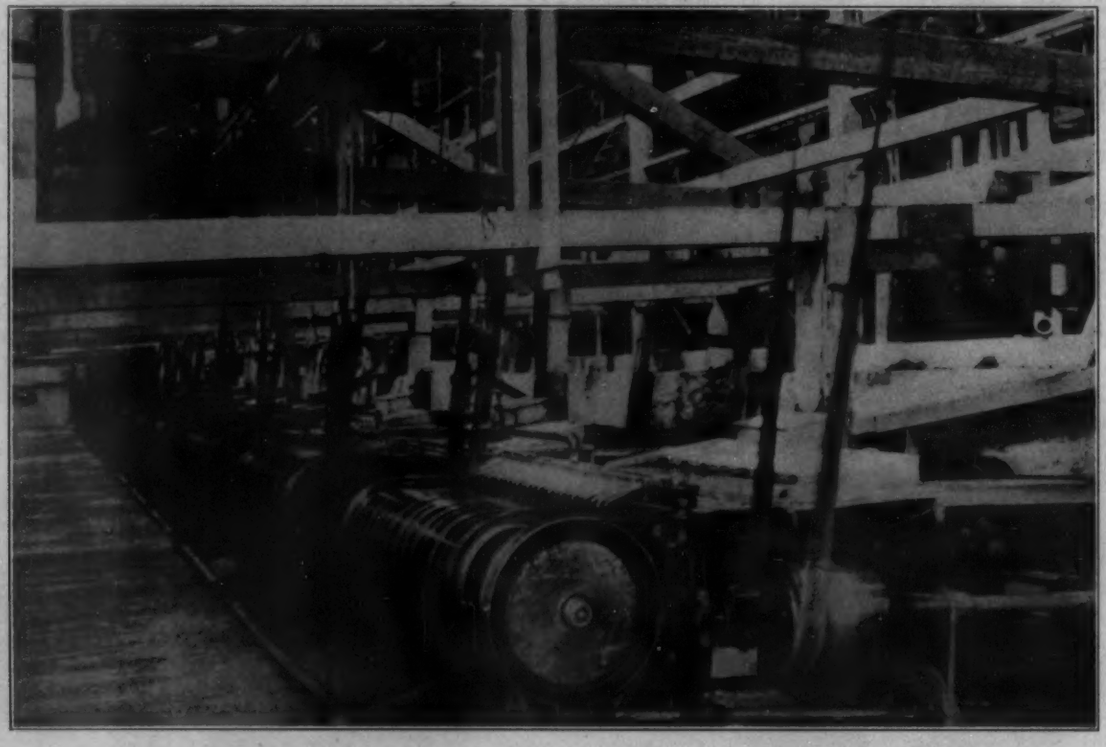
Given the heat units in a pound of wood and the pounds of wood per cord, let us now proceed to demonstrate the cost of steam power with wood for fuel.

A pound of saturated steam at 90 pounds gauge pressure contains 1215 heat units. If the feed water, after passing through an exhaust heater, has a temperature of 150° F., then the actual heat units absorbed by each pound of water evaporated, will be 1215—150=1065 British thermal units. The theoretical evaporation of a pound of wood under these conditions will be $\frac{5000}{1065}$=4.69 pounds, which are the heat units contained in a pound of wood, divided by the heat units required to evaporate a pound of water.

Assuming a boiler efficiency of 65 per cent (which is as good as can be expected when working under variable loads), the actual evaporation under working conditions will be: 4.69x.65=3.048 pounds of steam per pound of wood; a cord of wood, then, weighing 2000 pounds, will evaporate 3.048x 2000=6096 pounds of water into steam at 90 pounds gauge pressure.

The ordinary simple non-condensing steam engine will consume 30 pounds of steam per horsepower hour, working on unsteady loads. If, then, we divide the total pounds of water evaporated by a cord of wood into the pounds of steam consumed per horsepower hour by the engine, we get $\frac{6096}{30}$=203 horsepower hours. Taking the cost of wood at $5.00 per cord, the cost per horsepower hour will be $\frac{\$5.00}{203}$ =$0.0247. As there are 720 hours in a thirty day month, the cost per horsepower per month will be $0.0247x720= $17.78. While it is possible to do somewhat better than this with a plant working under favorable conditions, it will be found in general mining practice that the price is rather above this figure than below it.

Through the kindness of Mr. J. C. Kemp Van Ee, of the Royal Consolidated Mine, Calaveras County, I am able to present the results of an efficiency test of a steam plant working under almost ideal conditions. The plant in question is driving a 40-stamp mill, consisting of 20 stamps weighing 1050 pounds each, and 20 stamps weighing 800 pounds each, all with a drop of 5½ inches, making 110 drops per minute. The mill contains 12 concentrators in addition to the mill equipment, and the engine drives a 7-kilowatt generator for supplying lights for the mill and houses. The results of this test follow:



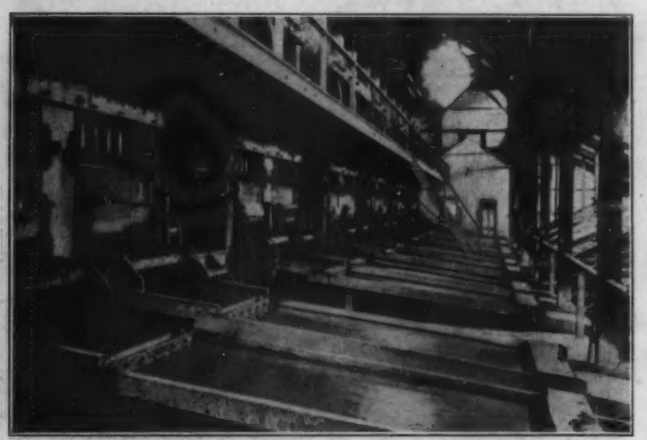
THE ONEIDA CONCENTRATORS ARE DRIVEN BY A 30 HORSEPOWER INDUCTION MOTOR

EVAPORATION TEST OF SECOND GROWTH PINE WOOD.

Type of boiler	Horizontal tubular.
Size of boiler	66 inches diameter by 16 ft. long
Number of tubes	98 three-inch tubes.
Heating surface of shell	=132 square feet.
Heating surface of tubes	=1230 square feet.
Total heating surface	=1362 square feet.
Grate surface	25 square feet.
Ratio of heating surface to grate surface	=54.5 to 1.
Duration of test	10 hours.
Amount of wood burned	=2⅝ cords.
Weight of wood burned	=9331 pounds.
Weight of wood per cord	=3554 pounds.
Total water evaporated	=25,124 pounds.

Temperature of feed water....60 8° F.
Steam pressure, average gauge. 101 4 pounds.
Water evaporated per pound of
wood, actual conditions....=2.693 pounds.
Water evaporated per pound of
wood from and at 212°....=3.224 pounds.
Quality of steam.....Practically dry.

While the test shows an evaporation of 3.224 pounds of water per pound of wood, the results actually obtained in practice are about 12 per cent better than this, as the feed water is heated by the exhaust steam from the engine and enters the boiler at 198° F. Owing to the difficulty of arranging the weighing device for handling the feed water after passing through the heater, we were forced to use cold water, cutting the heater out of service. Adding this 12 per cent, the evaporation is 3.61 pounds of water per pound of wood.



THE 60-STAMP MILL AT ONEIDA MINE IS DRIVEN BY A 150 HORSEPOWER INDUCTION MOTOR

The heat units imparted to the water were 1117x25,124=28,063,508. Assuming an efficiency of 70 per cent for the boiler, the total heat units given out by the wood was $\frac{28,063,508}{70}$=40,090,725, and the heat units per pound of wood amount to $\frac{40,090,725}{9331}$=4296, which is about right for that class of wood.

The power cost for running this mill with wood at $4.25 per cord, is as follows:

Fuel cost per horsepower hour.....	$0.0103
Labor cost per horsepower hour....	0.0023
	$0.0126

Making the cost per horsepower per month to amount to $9.07.

The results obtained from this plant are surprisingly good, but it must be borne in mind that it is a very efficient plant, which is working under the most favorable conditions. The boiler and engine are properly proportioned for the duty, the load is constant, the engine cuts off at the proper point to obtain the best results from the expansion of the steam, and the feed water is heated to a remarkable degree. I think it will be acknowledged that a plant operating under the fluctuating conditions of the average mining load, such as hoists, air compressors, pumps, rock crushers, sawmills, etc., that the consumption of steam per horsepower hour will reach from 30 to 35 pounds instead of 23, as shown by the test data above, and the efficiency of the boiler will be below 70 per cent.

Coal.

A good quality of steam coal yields 13,000 British thermal units by oxygen calorimeter, the approximate analysis being as follows:

Moisture	3.50 per cent.
Volatile combustible matter..	34.27 " "
Fixed carbon	54.23 " "
Ash and waste	8.00 " "
	100.00 per cent.

This quality of coal can be landed at the mines for about $13.00 per ton of 2240 pounds. Under the same conditions upon which wood was figured, the cost of power, using coal for fuel, will be approximately as follows:

Theoretical evaporation=12.2 pounds of water per pound of coal.

Actual evaporation under working conditions=7.93 pounds of water per pound of coal, which=17,763 pounds of steam per ton of coal.

Horsepower hours per ton of coal=592; cost per horsepower hour=$0.022; cost per horsepower per month=$15.84.

While this cost appears somewhat less than wood, yet for general mining work wood has many advantages over coal.

Fuel Oil.

We now come to the real competitor of electric power in California,—wood and coal having fallen an easy prey—but oil offers a more stubborn resistance, especially in the valleys or at tide water, where it can be landed to the customer at a price of 67 cents a barrel. In the mining districts, however, where the transportation rates are high and oil costs $1.50 per barrel, it is not such a formidable foe. It is well, however, for the transmission people to keep informed on the oil situation, for oil has come to stay in California.

Within the past few years, the oil developments in this state have been phenomenal, and the hundreds of thousands of acres of oil lands which are already prospected and developed, insure a supply for many years to come. The oil sands in the Kern River and Bakersfield districts range in thickness from a few feet to five hundred feet, and they contain from 30 per cent to 40 per cent of oil. Of course, all of this cannot be extracted by the ordinary methods of pumping, but it is safe to say that 10 per cent of the bulk of good oil sand is extractable.

Here are some characteristics of various crude oils:

ANALYSIS OF BEAUMONT CRUDE.

Gravity	= 21° B.
Flash point	= 142° C.
Burning point.....	= 181° C.
Cold test	= —6° C.
Carbon	= 85.03 per cent.
Hydrogen	= 12.30 " "
Oxygen and Nitrogen...	= .92 " "
Sulphur	= 1.75 " "
	100.00 per cent.

British thermal units by oxygen calorimeter=19,060.

5 per cent of steam required to vaporize in burners.

ANALYSIS OF VENTURA COUNTY CRUDE.

Gravity	= 23.5°B.
Carbon	= 84.0 per cent.
Hydrogen	= 12.7 " "
Nitrogen	= 1.7 " "
Oxygen	= 1.2 " "
Sulphur	= 0.4 " "
	100.00 per cent.

GRAVITY OF DIFFERENT CALIFORNIA OILS.

Central oil fields, Los Angeles	16° and 17° B.
Mackintosh wells, Los Angeles	13° B.
Maltman Tract	14° B.
Summerland, Santa Barbara Co.	15° to 17° B.
Sunset Oil District, Kern Co.	15° B.
Tar Creek	23° B.
Four Forks	22° B.
Kentuck	25° B.
Coalinga (Oil City)	34° B.
Puente Oil Wells	23° to 28° B.
Pacific Coast Oil Co., Pico Canyon	40° B.
Tuntas Creek, San Mateo Co.	45° B.
Moody Gulch, Santa Clara Co.	44° B.

GRAVITIES OF CRUDE OIL. BEAUME HYDROMETER, TEMPERATURE, 60° F.

	Specific Gravity.	Weight per Bbl.	Barrels per Ton.		Special Gravity	Weight per Bbl.	Barrels per Ton
15	.9655	338	6.63	28	.8860	310	7.24
16	.9589	338	6.69	29	.8805	308	7.28
17	.9523	334	6.73	30	.8750	306	7.32
18	.9459	331	6.77	31	.8695	304	7.37
19	.9395	328	6.82	32	.8641	302	7.42
20	.9333	326	6.87	33	.8588	300	7.47
21	.9271	324	6.91	34	.8536	299	7.52
22	.9210	322	6.96	35	.8484	297	7.56
23	.9150	320	7.01	36	.8433	296	7.60
24	.9090	318	7.06	37	.8383	294	7.65
25	.9032	316	7.10	38	.8333	292	7.70
26	.8974	314	7.15	39	.8284	290	7.75
27	.8917	312	7.19	40	.8235	288	7.79

It will be seen from the table that the weight per barrel varies perceptibly with the gravity, and at first sight it may appear that the low gravity oil would be cheaper to use, but in fact there is very little difference in the fuel value of a barrel of oil, whether the gravity be 14° or 34°; for while there are more pounds in a barrel of low gravity oil, there are less heat units per pound.

From an average of several samples that I have tested, 16° B. oil contains 18,000 British thermal units per pound, and 34° B. oil contains 22,200 British thermal units.

Coming back to the original subject, let us work out the cost of steam power with oil for fuel, under the same conditions that wood and coal were treated.

A barrel of 16° B. oil weights (allowing for wastage) 330 pounds, delivered; heat units per pound=18,000, theoretical evaporation=16.9 pounds; actual evaporation—boiler efficiency at 65°=10.98 pounds; pounds of water evaporated per barrel of oil=3623; horsepower hours per barrel of oil=120.7; price per horsepower hour, oil at $1.50 per barrel=$0.0142; price per horsepower per month=$8.93.

This result can be obtained under the most favorable conditions, but it is safe to say that with ordinary mining practice, it will cost at least 30 per cent more than this amount, for oil on a variable load is more difficult to handle economically than either wood or coal, and the losses are consequently far greater. The true cost per horsepower month, would then be fully $11.90.

Taking the cost of electric power at $6.50 per horsepower month, the comparative costs for power will be as follows:

Wood	$17.78	Saving effected by electric power	$11.28
Coal	15.84	" " " " "	9.34
Fuel oil	11.90	" " " " "	5.40

The mine superintendent takes kindly to the electric motor for all purposes except for hoisting, and to my mind his exception is well taken, for until a simple, better and more reliable electrical hoist is developed I will hesitate to recommend them to a customer. In my opinion, compressed air is going to be universally used for hoisting purposes, where cheap electric power is obtainable and when a compressor is required for other purposes in the mine. In the ordinary use of a compressor at a mine, it is not used to its rated capacity more than 40 per cent of the time. If, then, receiver capacity be available to store the air at times of light demand upon the compressor by the drills, and thus enable the compressor to be operated at full load all the time, the motor and compressor would be run at their highest efficiency and sufficient air could be stored to operate the hoist under ordinary conditions, and quite efficiently, too, by re-heating the air. It is not generally known that a pound of coal used for re-heating air will produce a horsepower hour, while it requires from four to five pounds of coal to give the same result with steam; but such is the case, if the air be used in an engine fitted for the purpose.

But, for the sake of argument, let us suppose that we use the air without re-heating, and assume that air and steam are equal, so far as expansive effects are concerned; then, if electric power costs $6.50 per horsepower per month, and the compressor has an efficiency of sixty per cent., the cost for air delivered to the engine will be $10.83, as against oil at $11.90, and by using a small amount of fuel for re-heating, these results can be far exceeded.

AT THE KEYSTONE MINE A 300 HORSEPOWER INDUCTION MOTOR RUNS A COMPRESSOR THROUGH A ROPE DRIVE

At the Lightner Mine, Calaveras County, electric power has been used exclusively for several years. A 150-horsepower motor drives a two-stage compressor thirteen inches by twenty-two inches stroke, and running at seventy-five revolutions per minute. The sawmill, a pump and a blower are also driven by the same motor. The relief pipe from the air receivers is connected to the steam boilers, two of which act as additional receivers, and another one of them being used as a re-heater. About one cord of wood is burned per day in re-heating. There is operated a sixty-stamp mill, which is driven by a 100-horsepower induction motor; a twenty-horsepower motor drives the rock crusher, and a five-horsepower motor is used for operating a telpherage system for carrying sulphurets to the chlorination works. All the hoisting is done with compressed air, as is also the lifting of all the water, which is taken from the 600-foot level. In addition to this work, seven 3¼-inch drills are supplied with air from the same compressor. The total power bill for January, 1902, was $1,457.50, including the cost of the wood used for re-heating purposes, which makes the power cost per ton of ore milled to be twenty-one cents, including all power charges.

Through the kindness of Mr. J. B. Tregloan, of the South Spring Hill Mine, near Amador City, I am permitted to present some data on results obtained at his plant, and which were published in "The Mining and Scientific Press," for April 20th, 1902. This publication gives the results actually obtained at this mine, as follows:

The South Spring Mine is using a 10x18-inch duplex,

single-stage, belt-driven compressor, the area of the outlet ports being nine inches square on each end of each cylinder, the port area being reduced to six and one-quarter square inches, where it enters the main pipe, which is a disadvantage, but which in this particular compressor, is unavoidable. The water jacket covers only three-fourths of the surface of the cylinder, one-quarter being taken up by air ports, which is another defect in construction. The working pressure varies from seventy-five to eighty-five pounds, blowing off at eighty-five pounds. The compressor runs fifty-nine revolutions per minute, the valves being of the ordinary poppet type.

In driving this machine, a 30-horsepower General Electric "Form K" compressor type induction motor is used; speed, 900 revolutions per minute; voltage, 550; the current being transformed from 10,000 volts in a separate building, about 250 feet from the compressor house, and measured on the low tension side by an integrating Schallenberger wattmeter, 746 watts being considered the equivalent of a mechanical horsepower. The current is transmitted from the Standard Electric Company's plant, near Jackson, Amador County, California, a distance of eight miles. The price per horsepower by meter measurement is $6.50 per month, which is the maximum rate, and which is reduced somewhat according to the amount of horsepower contracted for above a certain amount. The compressor pumps directly to a small receiver, in this case too small by 500 cubic feet, the total storage

A RELIC OF THE PAST—A WATER WHEEL ROPE DRIVE

being only about 100 cubic feet, allowing altogether too sudden fluctuations in air pressure, and not enough to carry all the air compressed during the small periods of idleness of power drills and hoisting engine, without blowing off air.

This brings up the important point in compressor practice, that blowing off air is a large item of expense, is wasteful and is an apparent negligence of proper installation, but for some unaccountable reason it is generally considered unavoidable in a compressor plant. Provide plenty of storage capacity, and install the right size of compressor, and compressed air will be an economical and not an expensive commodity, as is the opinion of most of its users.

In the case of the South Spring Hill Mine, the blow-off of the receiver is so arranged that it empties into the steam boiler, where it is re-heated and used in the hoisting engine, passing in just above the water line through the front end of the boiler, as shown in the illustration herewith. When the power drills are not operating, the lever is raised and all the air passes to the boiler for hoisting purposes. Attention is called to the accompanying sketch already referred to and showing the general arrangement of the plant. Where it is possible to do so, elbows are avoided and long sweeps, made by bending the pipe, are used; these bends being made very carefully to avoid any crushing of the side of the pipe.

Where pressure in the receiver rises above seventy-five pounds per square inch, it overcomes the weight and escapes through the three-inch check valve, whence it passes out through the side opening of two and one-half inch tee (through which passes the stem shown in dotted lines), and thence to the steam boiler. A check valve shown in the illustration prevents the steam from backing out of the boiler when the air is below steam pressure; this arrangement makes the blow-off on the steam boiler to be the blow-off of the compressor. Air is used cold in the power drills, but in the engine it is re-heated to about the temperature of steam at forty pounds pressure.

The average consumption of fuel used in combination with electricity in this plant for sixty days was—

Twenty horsepower per day at a cost of	$ 270.00
Wood burned in meantime, 37½ cords at $6	225.00
Total cost of power	$ 495.00
Under former conditions it required—	
Two cords of pine wood per day, 120 cords at $6	$ 720.00
Water power for compressor (very favorable conditions), two months	350.00
Total by wood and water	$1070.00
Tons of rock broken by power drills, and hoisted 550 feet	2667
Tons of water hoisted 600 feet	3600

Under the present conditions, should the power drills and hoisting engine be idle, all at once, for more than one minute, the air blows off because of the lack of storage, which, as soon as rectified, should make a difference of at least ten cords of wood. Electricity at $6.50 per horsepower month is at the rate of about twenty-one cents per horsepower for twenty-four hours. Consuming, as this plant does, about twenty horsepower per day, means $4.50 per day to produce enough air at eighty pounds pressure to operate two power drills (3¼-inch cylinders), and leave a surplus for the hoisting engine sufficient to save the use of over one and one-quarter cords of wood per day. Hal all the air pumped to eighty pounds been conserved by ample storage, the use of less than one-half cord of wood would have been sufficient for all re-heating purposes, and supply steam at times when air pressure was low.

The results obtained by the use of compressed air for hoisting purposes in the above instances, should convince the most skeptical mind that it is economy to use compressed air for hoisting with electric power at $6.50 per horsepower per month, against the prevailing prices of fuel. At the present time there are several large compressed air plants in course of erection in Amador County, all of which are to be electrically driven, and re-heated air is to be used for hoisting.

With an installation of this kind properly proportioned as regards motor, compressor and receiver capacities, to my mind, it leaves little to be desired, from the point of economy, convenience and reliability.

The old Keystone Mill consisted of forty 725-pound stamps, ninety-six drops, 7.5-inch fall, and sixteen concentrators.

The total power required was eighty-five horsepower, or 2.12 horsepower per stamp. When this mill was operated by steam, using pine wood for fuel, seven cords per day were consumed; this, at $5.00 per cord, equals $35.00 per day, or $1,050.00 per month; add to this the wages of two firemen, equals $1,200.00 per month. The cost of electric power at $6.50 per horsepower per month equals 85x$6.50 equals $552.50, showing a saving of $647.50 per month.

This mill has recently been increased to sixty stamps and

twenty-four concentrators. The new stamps are 1,000-pound, making 100 drops, 5.5-inch fall.

Measurements made on the Central Eureka Mill showed a consumption of forty-six horsepower for twenty 850-pound stamps, ninety drops, 6.5-inch fall, including eight concentrators. This is at an average of 2.3 horsepower per stamp. The mill was driven by a fifty-horsepower induction motor. Since this data was obtained the owners have increased the capacity of the mill to forty stamps, and have installed a 100-horsepower motor to drive it. Preparations are now being made to install an air compressor to be driven by the fifty-horsepower motor taken from their mill, and when this is done compressed air will be used for drilling and hoisting. The total electrical installation will then be:

Mill	100	horsepower
Compressor	50	"
Rock crusher	12.5	"
Blower	7.5	"
	170	horsepower

The Oneida Mill is running sixty 1,100-pound stamps, ninety-four drops, 7.5-inch fall. The power required to run the mill, including thirty concentrators, is 175 horsepower, or 2.91 horsepower per stamp. The stamps are driven by a 150-horsepower induction motor, and the concentrators are driven by a thirty-horsepower motor. The motors, batteries and concentrators are shown in figures 3 and 4.

This mine is also using a 50-horsepower motor on its rock crusher, a 75-horsepower motor in its sawmill and a 125-horsepower synchronous motor driving its air compressor. It is preparing to install a 125-horsepower motor in the mine for driving a pump, which will make a total installation of 555 horsepower. The total power cost per ton of ore milled at this mine is about thirty cents. The cost of power for the mill when all stamps are run continuously is $1,137.50 per month. This mine is hoisting and pumping by steam, with oil for fuel.

I might mention that a 100-horsepower motor has recently been installed in this mine for driving a pump, and is doing excellent work. I understand this pump is to be the subject of a paper to be presented at this meeting. My belief is that electrically-driven pumps will soon be a common thing on the Mother Lode, and from the point of efficiency and convenience, it certainly leads any of the methods now employed.

It is well understood that the ordinary steam pump is a very extravagant piece of apparatus, owing to the fact that it takes steam full stroke, and makes no pretense of cutting off in order to use the steam expansively; this is especially true when compressed air is used instead of steam, for it must be distinctly understood that economical results cannot be obtained with compressed air, unless the benefits to be derived from expansion are taken advantage of. In order, then, to realize the best results from compressed air for pumping purposes, an engine-type pump should be used with an adjustable cut-off, thus enabling the valves to be set for the duty the pump is to perform.

While compressed air affords a very convenient method of pumping, the difference in efficiency between that method and electrically-driven pumps, permits of no argument, electricity having fully thirty per cent. the advantage.

MOVING-PICTURE EXHIBITS AND THE DEPARTMENT OF ELECTRICITY, WATER AND GAS IN NEW YORK CITY.

The Department of Electricity, Water and Gas, New York City, in conjunction with the Fire Department and the National Board of Fire Underwriters, has been conducting a crusade against the manipulators of moving-picture machines in New York City. About a year ago the electrical bureau of the Department of Electricity, Water and Gas began a careful inspection of these devices and discovered great indifference to rendering this apparatus even a reasonably safe fire hazard. New York City, in fact, is the pioneer in the movement toward making these machines safe. In most instances, when this crusade was begun, the celluloid films were placed upon an open reel at the top of the machine and allowed to fall into a flannel bag at the bottom of the machine, without any protective devices or shields surrounding this highly inflammable material. Under the direction of the experts of the electrical bureau the machines are now being equipped with sheet metal cases encasing the reels both above and below the projecting apparatus. Where the celluloid film leaves the upper case, and again where it enters the lower case, it passes between brass rollers, which would smother any flame which might be started outside of the cases. This would effectually prevent the greater portion of the film taking fire and creating an extensive conflagration.

It has been demonstrated that the operator sometimes held the film in the beam of light from the arc lamp, while making an adjustment at the arc, so long that the film took fire. In order to obviate this possibility the machines are now fitted with an automatic screen, so arranged that the beam of light cannot fall upon the film until the machine has come up to speed. In this way, if the operator stops the movement of the film, the filter is interposed between the arc light beam and the celluloid.

The department has also prescribed certain regulations affecting the use of resistances, flexible connections and arrangement of auxiliaries.

The Department of Electricity, Water and Gas, in order to make violations of its recommendations as few as possible, is now issuing permits good for thirty days. The number indicated on these certificates must correspond to the number of the name plate on each machine. This obviates, in a measure, the possibility of the operator securing a number of certificates upon one good machine by moving it from place to place, and operating a corresponding number of bad machines in different sections of the city.

30,000 VISITORS EXPECTED AT LOS ANGELES DURING THE N. E. A. CONVENTION.

Los Angeles expects over 30,000 visitors to the National Educational Association convention, which is to be held in that city July 8th to 13th of this year. Elaborate preparations are being made for the entertainment of the excursionists, not only by Los Angeles, but by nearly every community in the State. The trains will be met at the State line by members of the Reception Committee, who will greet the visitors with California fruits and flowers. From the arrival of the first contingent of excursionists, California will keep open house. The railroads have made exceedingly low rates. From Chicago and intermediate points the rate will be one fare plus $2.00 for the round trip. In the State the rate for California side trips will be one and one-third fares for the round trip from Los Angeles and San Francisco to interior points of the State. Stop-overs will be granted at any point en route. These tickets will be sold to the excursionists and any friends accompanying them. California has become the all-the-year-round playground of America. The beach and summer resorts, with their unexcelled hotels, will offer an inducement to the excursionists to make this trip their summer outing, as the tickets are good for final return until September 15th. Los Angeles is the center of an electric railway system of nearly 700 miles of inter-urban and 175 miles in the city, which gives cheap and easy transportation to the resorts of Southern California.

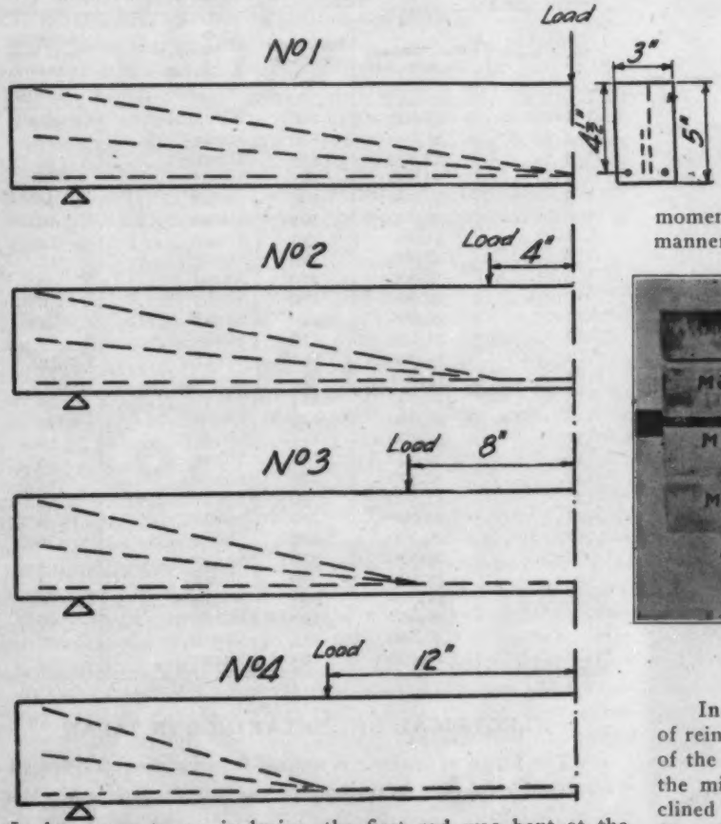
At the convention the principal addresses will be made by some of the most distinguished scholars of Europe and America. The University of California at Berkeley will hold a Summer School, at which it is expected a large number of the visitors will be in attendance on account of the opportunity to combine the pleasure of a California outing, attendance at the National Educational Association convention and Summer School work.

VARIOUS METHODS OF REINFORCING.*

The proper method of reinforcing a beam against various internal stresses is a very important one, and as yet has not been satisfactorily determined. When reinforced concrete first came into general use it was thought that horizontal reinforcement was sufficient, and the peculiar failures which often occurred were usually ascribed to pulling out the rods, an idea which led to the invention of the various forms of deformed bars now on the market. It has been found, however, that even beams reinforced with deformed bars often fail along inclined cracks, and that something besides horizontal rods is necessary to prevent such failures. Stirrups have been used extensively with this end in view; although they assist in carrying the internal stresses to some extent, their use in the usual manner will not always prevent inclined tension failures.

Messrs. Gilman and Kahn used stirrups in a number of their beams, and, although these beams were found to be somewhat stronger than those without stirrups, they still failed to develop the full compressive strength of the concrete or the tensile strength of the steel.

Another method used in their tests, and also in the succeeding ones, was to bend the horizontal rods at an angle of forty-five degrees at equal intervals between the loading points and the support. The results of all these tests are given in Table M-3. The beams were all 5-inches by 3-inches in section with a span length of 48 inches, made of a 1:2½ mortar, and reinforced with four ¼-inch round rods. The positions of the loads are given in the table. The rods were bent up at the quarter points between loads and supports.



In beams 13 to 24, inclusive, the first rod was bent at the point of loading, the second rod was bent at one-quarter of the distance from this point to the support, and so on; thus no rod was horizontal all the way through. In beams 1 to 12, inclusive, the first rod was bent at the point where the second one was bent in the previous beam, so that in each beam one rod was straight over its full length. In both cases all of the four rods were horizontal between loads. The four rods were tied in a bundle so as to make the section as nearly symmetrical as possible with respect to a longitudinal plane through the center of the beam.

With the exception of three of the beams with loads at or near the center all these beams failed by inclined tension, this being the favorite method of failure of all beams reinforced with only horizontal rods. The failures occurred on lines through the bent rods, the rods slipping sooner or later as the bent portions were not long enough to offer sufficient adhesion to carry the inclined stresses. Strictly vertical shear failures were obtained in several of the beams of this set which had the loads applied very close to the support. The inclined tension failures are here called shear failures and the same term is also used in all the other tables, so that, except for the several beams in Table M-3 which failed by vertical shear, wherever a failure is called a shear failure, inclined tension is meant.

Another method of bending the rods was tried with better results. This series consisted of four beams reinforced as shown in the diagram, Figure M-3, with two rods running straight through and two bent at the loading points. The inclined cracks as they usually occur in a concrete beam are approximately perpendicular to the direction of these rods; therefore, these rods should be very efficient in preventing this failure. This was actually found to be the case. Series G, the results of which are given in Table M-3, was designed for the special purpose of determining this in a preliminary way, and all the large beams made later were provided with this system of reinforcement.

Three of the beams of Series G failed in tension at the center, while similar beams with the same loading and provided with only straight rods or rods bent at an angle of forty-five degrees failed by inclined tension. In the last beam, G-4, the loads were too near the supports to give a moment failure. A photograph of these beams showing the manner of failure is given in Plate M-II.

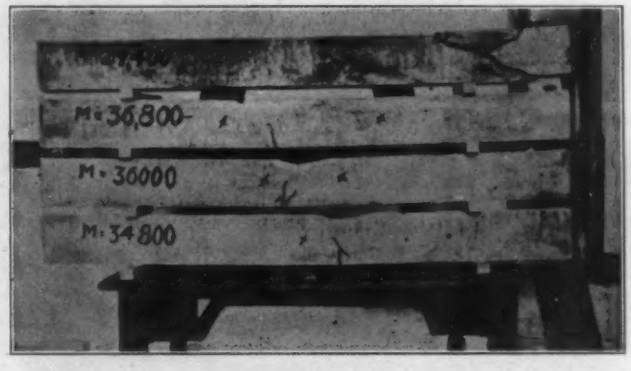


PLATE M—II.
Beams of Series G after testing.

In the tests of the 8-inch by 11-inch beams this method of reinforcement gave equally as good results. All the beams of the 1:2:5 concrete, except No. 13, failed by tension within the middle third of the beam. In every case the usual inclined cracks near the ends appeared, but were prevented from developing by the bent rods. Two per cent. reinforcement was stressed to its elastic limit in these beams. In the case of No. 13 failure near the end occurred after the cracks near the center had opened up considerably and the steel had apparently been stressed to its elastic limit. In fact, this beam carried a greater ultimate load than its duplicate, No. 15, which failed by tension near the center. It is desirable to emphasize the fact that this failure was not caused by a

*"Tests on Reinforced Concrete Beams," by Ernest Anthony Moritz. Bulletin No. 148, issued by the University of Wisconsin.

pulling out of either the inclined or straight rods. The final failure occurred by a prying up of the upper half of the beam at the end, which seems to indicate that stirrups would be very efficient at this point in connection with the inclined rods.

Three of the 1:3:6.5 beams failed by inclined tension. These failures were perhaps due to slipping of the inclined rods. By comparing these three beams, Nos. 10, 12 and 16, with the others of this set it is seen that similar beams failed by compression at the center with practically the same or smaller loads, and that, therefore, these three beams had probably reached their full compressive strength when failure near the end occurred.

Anchored Rods.—It has been claimed that beams with straight rods anchored at the ends are stronger than without

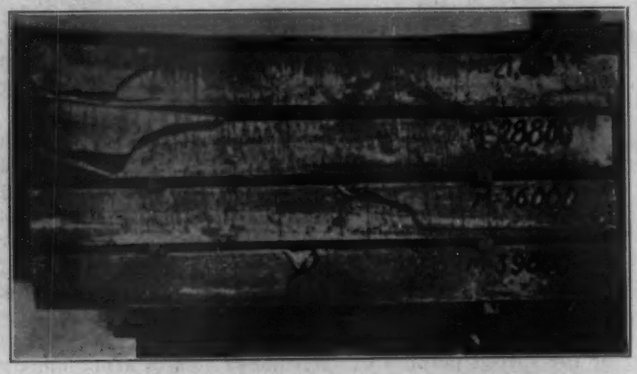


PLATE M—IV
Beams with anchored rods after testing

the anchorage, and that the horizontal cracks often observed in the plane of the reinforcement are due to pulling out of the rods. With a view to investigating this, four beams were made with horizontal rods anchored at the ends. The anchorage consisted of a rectangular bar of steel with holes bored through to allow it to be slipped over the ends of the reinforcing rods. The rods were then bent back over this bar so that they had a firm bearing. The loads were applied at 12, 16, 20 and 24 inches from the supports. Plate M-IV is a photograph of the broken beams. From the picture it is seen that all four beams failed in the manner typical of beams with only horizontal reinforcement.

Plate M-V shows the condition of the ends of two of

PLATE M—V
View of anchorage after test

perfectly solid, the rods did not slip at the ends; therefore this crack cannot be due to pulling out of the rods. A comparison of the strengths of these beams with those of Series B is given in Table M-2. Since the two sets of beams were exactly alike except for the anchorage, the results are directly comparable.

It would be rash to draw final conclusions from these few tests, but they seem to show, first, that the horizontal the beams, from which it is seen that as the anchorage was crack in the plane of the reinforcement is not due to pulling out of the rods, but that it is due to the pulling of the concrete upwards away from the rods, and therefore cannot be prevented by anchoring the rods at the ends; and, second, that anchoring the rods does not make the beams stronger with the proportions here used.

Table M—2.

Comparison of Strength of Anchored and Unanchored Rod Beams.

No. of beam.	Max. Load.	
	Anchored.	Not anchored.
1	3300	3500
2	3600	3700
3	3600	4300
4	3600	4900

Table M—3.

Strength of Beams With Varying Points of Loading.

5-in.x3 in. x 48-in. span; net depth, 4½ in. 1.44 per cent. steel, 60,000 lbs. elastic limit; 1:2½ mortar.

Note—Beams marked "A" had rods bent up at an angle of 45 degrees at quarter points between loads and supports. Beams marked "G" are shown in Fig. M-3.

No. of beam.	Max. moment. Inch-pounds.	Max. shear pounds per Sq. in.	Kind of failure.	Distance of loads from supports. Inches.
A 1	39,400	110	Moment	Center
A 2	47,100	140	Shear	22
A 3	43,400	145	Moment	20
A 4	39,600	145	Shear	18
A 5	39,200	165	Shear	16
A 6	36,700	175	Shear	14
A 7	41,600	230	Shear	12
A 8	48,000	320	Shear	10
*A 9	32,800	270	Shear	8
*A10	24,600	270	Shear	6
*A11	26,600	440	Shear	4
*A12	11,100	370	Shear	2
A13	39,600	110	Shear	Center
A14	34,800	95	Moment	Center
A15	34,000	115	Shear	20
A16	36,000	120	Shear	20
A17	35,200	145	Shear	16
A18	30,800	130	Shear	16
A19	30,300	170	Shear	12
A20	27,300	150	Shear	12
A21	24,000	200	Shear	8
A22	24,300	200	Shear	8
A23	22,000	370	Shear	4
A24	19,600	330	Shear	4
*G 1	34,800	100	Moment	Center
*G 2	36,000	120	Moment	20
*G 3	36,800	155	Moment	16
*G 4	29,400	165	Shear	12

*50,000 lbs. elastic limit steel.

ELECTRICAL UNDERTAKINGS IN JAPAN.

The Japanese Empire is a good field for manufacturers of electrical devices. According to the list of Japanese enterprises formally organized and projected since July, 1905, furnished by Consul-General H. B. Miller, of Yokohama, the new capital of companies building electric railways amounts to $55,825,000, and the investment in other electrical enterprises is $49,711,500, of which $27,375,000 is employed in developing Japanese water-powers. Only $14,825,000 has gone into steam railways. In all $248,896,500 fresh capital has been contributed to Japan's industrial expansion since the Treaty of Portsmouth.

SOME IMPORTANT DATA REGARDING THE ELECTRIC FURNACE.

In connection with some very valuable experiments recently performed in the investigation of the compounds formed by the borides and the silicides through the use of high temperatures, some data concerning the electric furnace have been obtained which will be of general interest.

These tests were made by Mr. Oliver Patterson Watts, Ph. D., as subject matter for a thesis presented to the University of Washington for the degree of Doctor of Philosophy, and have been published by the university in bulletin form.

The electrical equipment used as the source and control of the current is described as follows:

The dynamo which supplied current for most of the experiments was a direct-current 110-volt machine, rated at 825 amperes. Alternating current with variable voltage was also available up to twenty kilowatts, and was occasionally used.

The direct current most frequently used was controlled by an iron water pipe rheostat of ten equal sections in series, having a total resistance of 0.5 ohm. With all but one section of the rheostat short-circuited, 600 amperes was delivered at a pressure of 80 volts at the furnace terminals. Of the total energy transformed by the generator, the per cent delivered to the furnace was as follows:

Average for an entire experiment.....68 per cent
During maximum load (600 amperes by 80 volts) .....73 per cent
Highest per cent for ten consecutive minutes in any experiment.....80 per cent
Highest per cent ever attained, for two minutes, by running the furnace directly from the dynamo.....94 per cent

The furnace was started with the entire rheostat in the circuit, which explains the low average. In experimental work, the convenience of this method of control more than compensates for the waste of energy. This waste of energy might be considerably diminished by having some sections of the rheostat of one-half and one-third the resistance of the others, with a generator voltage of eighty or ninety, instead of one hundred and ten.

It is stated by Mrs. Ayrton "without some external resistance, it is impossible to maintain a silent arc between solid carbons." From the behavior of the arc when the resistance of the rheostat was reduced to only 0.05 ohm, the writer believed that even this resistance might be dispensed with, and yet the arc would run steadily. This was verified by an experiment. The furnace was heated, as usual, with the line voltage at 110. The voltage regulator was then cut out, the voltage lowered to 70, and the last section of the rheostat short-circuited. The only resistance external to the arc was that of the cables and armature—between 0.012 and 0.018 ohm. The arc ran satisfactorily, although not so steadily as with one section of the rheostat in the circuit. The voltage of the generator was then raised to 80 with the result that the widest variations of current for an arc one and seven-eighths inches in length was from 310 to 450 amperes. It is probable that most of this variation was due to the defective form of the anode, developed during the preliminary heating. The average resistance of the arc was twelve times that of the remainder of the circuit, and consequently the per cent of energy delivered to the furnace was 92+.

In this experiment, it was observed that when the arc became silent after it had been "shrieking," the voltage across the terminals diminished and the current increased. This is contrary to Mrs. Ayrton's observation upon the open arc.

These differences between the action of the arc lamp and the arc furnace would undoubtedly yield interesting results if thoroughly investigated.

Electric Furnaces.

For the production of metallic borides and silicides by the direct reduction of oxygen compounds, the horizontal arc furnace was decided upon as most easily managed and best suited to the purpose.

Several different materials of construction were tried and rejected. Finally magnesite brick was decided upon as being by far the most resistant material available for the furnace. Other materials tried were limestone, ordinary fire brick, chromite, and silica brick. The only limestone obtainable was very easily broken, and as a furnace material cracked badly, even when protected from the arc by a graphite lining. It is quite possible that a harder, stronger limestone, and particularly a dolomite, might prove a satisfactory material for furnace construction. Ordinary fire brick cannot be used for the inner zone of an arc furnace because of its fusibility. Silica and chromite brick, while less fusible than fire brick, are still far from satisfactory. The former fuses and disintegrates by the heat of the arc, and the latter cracks badly before its fusing point is reached. Both are distinctly more fusible than magnesite brick, and are more readily attacked by slags.

In point of infusibility, magnesite bricks are very satisfactory, being melted to a depth of less than one-fourth inch by ten minutes exposure to an arc of 600 amperes at 80 volts only an inch below the brick. They do, however, crack under the influence of heat, and must be handled very carefully. These brick were obtained from the Harbieson-Walker Refractories Company.

In form, the furnaces consisted of a box built of magnesite brick without cement, surrounded by a second layer of fire brick. The dimensions of the horizontal arc furnace were: outside—20 inches square, 26 inches high; and inside—8¾ inches long, 7 inches wide, 7 inches deep—429 cubic inches. The outside dimensions included the ventilated base of fire brick. Although the table on which the furnaces stood had a thick cement top, it was found necessary to have air circulation between the body of the furnace and the table top.

The cover consisted of two magnesite bricks, and the electrodes entered through holes drilled in the bricks which formed the ends. Later, the ends were simply built up around the electrodes, and the cracks stuffed with asbestos paper. This type of furnace, with two modifications, was used in about 130 experiments.

Much trouble was experienced from the contamination of the products by iron. Even after all materials that entered into the composition of the charges were rendered iron free, the iron was still found, and its source was finally discovered to be the magnesite brick. A fused metal resting upon these in the presence of a strongly reducing slag, will be contaminated by iron. To remedy this, a bed of powdered magnesia, free from iron, was spread an inch deep in the bottom of the cavity. This prevented any contamination from the bottom of the furnace, but there was still occasional contamination from the side walls. For a part of the work, the entire inside, except for the bottom and the upper half of each end, was lined with inch-thick sheet graphite. Although this introduced carbon, it effectually prevented contamination by iron, and greatly prolonged the life of the magnesite brick. With the graphite lining, the inside dimensions were eight and three-quarters inches by five inches by six inches—262 cubic inches.

It would have been an advantage if the bottom of the furnace had been laid in cement, or strapped with iron to prevent the bricks from separating with the alternate expansion and contraction.

For the short duration of the heating, fifteen to twenty minutes, with a powerful current for less than half this time, the heat insulation was found to be ample. The outside layers of brick could be removed by the bare hands, if done as soon as the current was shut off, although an hour later they might become red-hot. The nearer air-tight the furnace is, without actually being so, the better.

The electrodes used were of Acheson graphite. The maximum current permissible on account of oxidation of the elec-

trodes outside of the furnace has been determined in the course of this work to be as given in the following table for twenty minutes heating:

Table IV.

Diameter.	Amperes.
1 inch.	400+.
1¼ inch.	650+.
1½ inch.	900.
2 inch.	1600.

The capacity of the first two sizes is from direct measurement; that of the last two is calculated from the areas of their sections, since the maximum current used, 700 amperes, never heated them to redness. If the heating is prolonged to an hour or more the current allowable is about 15 per cent less than in Table IV.

Although 600 amperes has been used for a short time with one inch electrodes, these become red their entire length, and undergo oxidation. It was found that this oxidation could be prevented by painting them with a paste of water glass and carborundum dust.

Moissan ("Le Four Electrique") has given the size of carbon electrodes suitable for furnaces of different horsepower. As he ordinarily used fifty or sixty volts, the latter value has been used in calculating the following table, except in one case where he specified seventy-five volts. The results as calculated from Moissan are given in Table V.

Table V.

Diameter.		Amperes.
m. m.	Inches.	
16-18	11/16	120
27	1	450
40	1½	1,250 (100 H. P.)
50	2	3,700 (300 H. P.)

In this table the current densities per unit area increase greatly with increase of diameter, although from the fact that the radiating surface increases less rapidly than the cross section, the reverse would be expected. Either the capacity of the smaller electrodes is greatly underrated, or that of the larger ones much overrated. The only carbon electrode tried by the writer was of one inch diameter, and this became red-hot outside the furnace at 150 amperes, although Moissan stated that he was able to use 450 amperes. It would be of interest to the worker with the electric furnace to know whether the relative conductivities of carbon and of graphite for heat are in the same ratio as their electrical conductivities, as is the case for the metals. If this is so, there will be no advantage of either over the other in regard to the amount of heat wasted by conduction from the furnace.

On account of their being such good conductors of heat, the graphite electrodes used should be the smallest that will carry the desired current. They should be slightly pointed before use, and set exactly in line in the furnace. The source of any irregularity in the operation of the arc is usually found in the anode, which corrodes irregularly, while the cathode keeps in good order without attention. One advantage of alternating over direct current for the arc furnace is that both electrodes tend to keep in good form.

In this series of experiments many observations were made upon the length of arc, its variation in resistance, electrode consumption, etc. Some of these observations are included here as of interest, and perhaps of value to other experimenters.

The longest arcs obtained were 15.5 and 14.4 centimeters (6 1/2 and 5 11/16 inches) at 104 volts, the former at 800 amperes. At the usual voltage of 80 on the furnace terminals, the length of arc for 600 amperes varied from 6 to 7.5 centimeters (2⅜ to 3 inches) as a rule.

Resistance of the arc depends upon:

a. Length.

b. Current strength. (See Table VI.)

Increase of current increases the cross section of the arc.

c. Temperature of the furnace.

During the rise in temperature at the beginning of an experiment the arc must be gradually lengthened if the current is to be maintained constant. When a cold charge is fed into a hot furnace the current is diminished.

Table VI.—Effect of varying currents upon the resistance of the arc.

No. of Experiment.	Amperes.	Volts.	Resistance.	R :R
98	600	75	.118	1
	360	75	.202	1.71
	210	79	.369	3.12
	190	82	.425	3.60
	150	81	.533	4.51
	140	83	.586	4.96
	120	79	.651	5.51
	120	81	.668	5.66
	100	81	.803	6.80
	70	80	1.136	9.62
	55	85	1.538	13.03
	40	92	2.293	19.43
111	580	78	.127	1
	400	72	.173	1.36
	330	77	.226	1.78
	280	77	.266	2.09
	200	81	.398	3.14
	160	81	.499	3.93
	200	76	.373	2.94
	180	66	.359	2.83
	150	77	.568	3.18
	120	75	.618	4.87
	130	75	.569	4.48
	120	70	.576	4.53
	120	70	.576	4.53
	110	71	.638	5.02
	75	83	1.099	8.66
	70	80	1.136	8.95
	80	89	1.105	10.97

d. Quantity and nature of vapors within the furnace.

An increase in the amount of vapors of sodium and of silicon lowers the resistance. Possibly there are vapors which are capable of increasing the resistance.

The data of Table VI were taken at the close of experiments when the furnace was very hot. Maintaining the length of arc unchanged, the current was cut down by increasing the external resistance. The pairs of bracketed readings were made about ten seconds apart with the same resistance in the circuit. An entire set of readings occupied about three minutes, so that the temperature within the furnace was practically constant. The column R1:R, shows the increase in resistance of the arc as the current is diminished and the external resistance is increased.

From the above and other similar data the writer draws the conclusion that **the arc tends to maintain a constant ratio between its own resistance and that of the remainder of the circuit, or an arc of fixed length tends to maintain a constant voltage.**

In experiment 111, the external resistance was varied about 900 per cent, the maximum variation in voltage of the arc was 14.1 per cent, and the average, only 1.8 per cent. The rise in voltage seen in the last readings, occurred but a few seconds before the arc died out. One readily pictures the shrinking of the arc to a mere pencil of carbon vapor as the current is diminished.

The above records were made after the vigor of the chemical reaction was over, for at the height of the reaction

the fluctuations of the instruments were usually too rapid to be read.

Table VIII.—General Data Concerning the Arc Furnace.

Exp. No.	Diam. of Electrodes.	Average K. W.	Time in Min.	K. W. x Min.	Volts.	Amp.	Length of Arc.		Resistance.		
							Inches.	C. M.	Total.	Per inch.	Per cm.
129	1½	28.0	36	1008	104	800	6 1/8	15.5	.123	.020	.0079
61	1¼	30.5	12	366	80	600	3 3/4	9.5	.126	.034	.0132
121	1½	28.6	30	859	81	550	3 13/16	9.6	141	.037	.0147
123	1½	28.6	61	1521	78	570	3	7.7	.130	.043	.0169
88	1¼	24.2	28	696	78	560	2 3/4	7.0	.133	.048	.0190
150	2	21.8	45	980	68	650	2	5.05	.098	.049	.0194
86	1¼	33.3	15	500	75	600	2 1/4	5.7	.118	.055	.0207
89	1¼	18.1	38	687	70	400	2 7/8	7.3	.168	.058	.0230
99	1¼	28.7	14	402	76	600	2	5.05	.120	.060	.0238
09	1¼	26.0	25	670	80	550	2 1/8	5.4	.138	.065	.0255
04	1¼	31.1	8	249	79	550	1 3/4	4.4	.118	.068	.0268
94	1¼	24.7	10	247	82	500	2 3/16	5.6	.157	.072	.0280
100	1¼	26.1	14	414	78	600	1 11/16	4.3	.123	.073	.0286
107	1¼	29.9	23	482	80	300	2 7/8	7.3	.259	.090	.0350
*127	1½	28.1	45	1264	103	150	5 11/16	14.4	.679	.119	.0470

*The current was cut down from 400 amperes to 150 by drawing out the arc instead of increasing the external resistance as usual. This is responsible for the abnormal resistance found.

The effect of an increase of current in lowering the resistance of the arc has already been pointed out; the other factor appears to be the temperature, estimating this from both the average and the total energy delivered to the furnace.

As has been already stated, the source of trouble when the arc is unsteady is to be found at the anode, and seems to the writer to be due to insufficient heat to maintain there a layer of carbon vapor.

There is a deposition upon as well as a vaporization of each electrode. The points of each are coated with smooth, lustrous graphite of extremely fine grain. There are two separate arcs. Each half of the current wave has its own exclusive territory on the electrodes. Each arc dies out with reversal of current; yet sufficient carbon vapor remains in its crater so that when this electrode is once more anode, the path of least resistance is from the crater rather than from any other part of the electrode. This phenomenon occurred only with a low voltage and large electrodes, and would seem to be possible only when the crater of the anode during each phase is small in comparison with the area of the end of the electrode.

Observations were made upon the loss in weight of graphite electrodes during several experiments. The results are given in Table IX.

Direct current was used in all except the first two experiments. These are marked A. C. and to them the terms anode and cathode do not apply. In these the electrode losing the more in weight extended into the furnace much farther than the other.

Electrode losses seem to be due to three causes:

1. Volatilization from the crater, confined to the anode.
2. Oxidation.
3. Disintegration—particles fall from the electrodes.

(1) is independent of, (2) and (3) dependent upon, the length of electrode within the furnace. The total loss is diminished about 50 per cent by filling the furnace with illuminating gas; this can diminish only (2) and (3). The losses with 2-inch electrodes were double those with 1½ inch diameter. This points again to the use of the smallest possible electrodes. It should be stated, however, that only a single pair of 2-inch electrodes were tested.

Table IX.—Loss in weight of electrodes.

	Exp. No.	Diameter of electrode.	Time.	Average K. W.	K. W. x time.	Loss in Grams.								
						Total.		Ratio.	Per minute.		Per average K. W.		Per K. W. minute.	
						Anode.	Cathode.	An. Cath.	Anode.	Cathode.	Anode.	Cathode.	Anode.	Cathode.
		Ins.												
A. C.	150A	1	37	6.9	229	17	14.3	1.19	.46	.40	2.40	2.35	.074	.062
A. C.	151B	1	60	11.6	695	28.8	19.6	1.47	.48	.32	2.48	1.69	.041	.028
D. C.	151A	1	9	13.4	120	11.3	2.02	5.13	1.24	.23	.84	.16	.094	.019
	139	1½	22	23.7	632	16.3	20	.81	.71	.87	.59	.72	.026	.031
	136	1½	58	25.1	1,457	59.3	32	1.87	1.02	.55	2.33	1.23	.040	.022
	138	1½	39	32.2	1,266	54.2	17	3.19	1.39	.44	1.68	.52	.043	.013
	137	1½	55	28.4	1,561	82.2	43	1.93	1.51	.78	2.91	1.51	.053	.028
	140	1½	22	23.7	523	49.0	15	3.27	2.23	.68	2.07	.63	.095	.029
Average . . .	.....	.....	.....	.....	.....	52.3	25	.....	1.37	.66	1.92	.92	.051	.025
	152	2	57	20.8	1,186	103.8	37.6	2.72	1.82	.66	4.98	1.81	.105	.038
	148	2	27	31.3	845	166.2	70.2	2.37	6.20	2.96	5.31	2.24	.197	.083
Average . . .	.....	.....	.....	.....	.....	135	53.9	.....	4.01	1.81	5.15	2.03	.151	.061
Furnace filled with illuminating gas	141	1½	38	31.4	1,142	23.5	10.4	2.26	.62	.27	.76	.33	.021	.009
	150	2	45	21.8	980	42.8	15.9	2.69	.95	.35	2.00	.73	.043	.016
	155	2	64	26.5	1,894	82	73	1.12	1.34	1.14	3.09	2.75	.043	.038
	151	2	46	14.2	656	56.1	9.3	6.03	1.22	.20	3.95	.65	.085	.014
	147	2	22	19.5	430	40.8	32	1.27	1.85	1.45	2.04	1.60	.095	.074
Average . . .	.....	.....	.....	.....	.....	55.4	32.5	.....	1.34	.78	2.77	1.43	.066	.035

DENATURED ALCOHOL: ITS PRODUCTION AND USES.*

Arthur H. Bosworth.

The law which permits the use of denatured alcohol has not long been in force. On May 24, 1906, the United States Senate passed the Denatured Alcohol Bill by unanimous vote. The bill had previously passed the House, after some opposition by the wood alcohol interests, and a few days later the signature of the President made it a law. Thus successfully ended the agitation for tax-free alcohol for use in the arts and industries, which began in 1888 and had continued intermittently for eighteen years. The passage of the law resulted from the effort of a manufacturer's committee organized to promote this legislation.

The law is a very important one for two reasons: it interferes with the domination of the oil trust over the supply of liquid fuel for heat, light and power; and it secures to the manufacturer the use of a valuable industrial agent. It provides that after the first day of this year alcohol produced under governmental supervision may be taken free of tax from bonded distilleries and warehouses for industrial purposes after being "denatured," by the addition of some substance which prevents the use of alcohol as a beverage.

The Wilson Bill, passed in 1894, provided for tax-free alcohol in certain industries, but the law was so defective that under its provisions it was impossible to provide tax-free alcohol and yet safeguard the revenue that the Government derives from taxes on alcohol used as a beverage. David A. Gates, for thirteen years an officer in the Internal Revenue Department and one of the experts who assisted in drawing up the Denatured Alcohol Bill, says that of the $750,000,000 in taxes, including postal revenues, raised by the Government annually, nearly 20 per cent ($150,000,000) comes from distilled spirits. Thus, although the need for tax-free industrial alcohol was great, it was impossible to jeopardize such a large part of our national income by providing such alcohol under the Wilson Law.

As the extent to which denatured alcohol will be used depends largely upon its cheapness, let us consider what it will cost to produce a gallon of denatured alcohol. This depends on the substances from which the alcohol is made and also on the substances used to denature it. Alcohol for use in the arts must be produced under Government supervision, but as the expense of this supervision is borne by the Government, it does not enter into the cost of production of the alcohol. Perhaps this cost can be understood more clearly if a few facts regarding the manufacture of alcohol are given.

Alcohol, C_2H_5OH, is composed of the elements, Carbon, Hydrogen and Oxygen combined in invariable proportions. As yet chemists have discovered no way of producing alcohol directly from its elements, although they have succeeded in making it from calcium carbide or barium carbide by indirect synthesis.

The commercial sources of alcohol, however, are fruits, starches, grains, and sugar producing vegetables.

"The raw material necessary for a gallon of alcohol 188 proof is 4.5 bushels of fruit, 0.36 of a bushel of grain, or 2 gallons of molasses. In the distillation of fruit and molasses there are no by-products: the first cost of alcohol produced from fruit or molasses therefore is the cost of the raw material, the labor, and the interest on the investment. The by-products at a grain distillery (stock feed and fusel oil) will pay the cost of operating, the labor and the interest on the investment. The cost of alcohol produced from grain is therefore represented in the price of the grain." (D. A. Gates in the January "World Today").

In Germany one of the greatest sources of alcohol is potatoes, and it has been found that one ton of potatoes yields 25 gallons pure alcohol.

If the source of alcohol is a starchy substance the material is ground up, steamed, and then mixed with malt and water at a temperature of 150 degrees Fahrenheit. Fermentation is then accomplished by brewers or compressed yeast, or by adding a saccharine liquid. The fermentation is carried as far as possible, so as to obtain the greatest amount of alcohol from the mixture. The liquid thus obtained is distilled. The product of the first distillation is impure, containing water and oils that have passed over from the still to the receiver along with the alcohol, and redistillation is necessary; unless one uses the method of combined distillation and rectification devised in 1900 by Edward Adam. This more modern method is described in an interesting article by M. Bandry de Saunier in a recent Scientific American Supplement.

It has been estimated that the average cost of a gallon of denatured alcohol to the consumer will be from 18 to 22 cents. In Germany, in the year 1902, 90 per cent alcohol sold for 11.5 cents per gallon, in 1905 the price advanced to 19 cents, the rise being accounted for by the fact that an alcohol trust controlled the market. In Louisiana, and a few other States, where crude "black-strap" molasses, a by-product of sugar manufacture, sometimes sells as low as 3 cents a gallon, in Nebraska, where the price of corn occasionally falls to 30 cents per bushel, or in localities where the soil is especially adapted to the growing of potatoes, the cost of production of alcohol may be no more than 10 or 11 cents per gallon. A prominent beet sugar manufacturer estimates that alcohol can be made from the waste of the beet sugar industry for 10 or 12 cents per gallon. Mr. G. A. Burns, a dentist of Los Angeles, suggests in a letter to the Scientific American that cactus is a cheap source of alcohol. Knowing that the natives of New Mexico make an intoxicating liquor from cactus, Mr. Burns experimented and, in a crude way, distilled one gallon of alcohol from five pounds of cactus. Cacti plants, he says, can be cut down, ground up, and put through the process of fermentation and distillation like corn, wheat, or barley He adds that Nevada cactus grows from two to five feet high very quickly and two months after being cut down it would grow up from the stubble and be ready to again produce industrial alcohol. Since in the West cactus grows abundantly and without irrigation or other attention, this may be one of the cheapest sources of industrial alcohol. The sources from which alcohol is made differ in different sections of the country. Either cactus, grain, molasses, fruit, or potatoes might be used, but economy decides the matter.

As was stated above, the cost of denatured alcohol will depend also on the cost of the denaturant. In some cases a substance essential to the manufacture of a certain article might be used to denature the alcohol, and as this substance would be needed in manufacturing the article anyway, its cost should not figure in the cost of the alcohol. However, in general, the cost of the denaturants must be a factor in the cost of production of denatured alcohol. The formula for denaturing the alcohol, given by the United States Internal Revenue Commissioner, is as follows: "To 100 parts ethyl alcohol add 10 parts approved methyl alcohol and one-half of one part approved benzine." Formulae of special denaturants are to be submitted to the Commissioner of Internal Revenue, who announces what formulae may be used.

The greatest need now is for an improved denaturing process. Methyl, or wood, alcohol is considerably more expensive than alcohol itself; and pyridine, another substance extensively used in Europe for this purpose, is far from cheap and has a very disagreeable odor. It is hoped that Yankee ingenuity will invent a cheaper and more agreeable process that is equally efficient. The following table, taken from an article by Mr. H. Diedericks in the "Scientific American Supplement No. 1596," shows what substances are used as denaturants in Europe. As several of the countries seek to keep their formulae secret, the table is based on analyses:

*From the Yale Scientific Monthly.

Materials Used to Denature Alcohol.

Country.	Sp. Gr. of Denatured Alcohol at 15 C.	Methylene (Wood Alcohol) and Impurities.	Pyridine, or Pyridine Bases Per Cent.	Acetone Per Cent.	Benzol Per Cent.	Benzine Per Cent.
France.	0.832	7.5	....	2.5	....	0.5
Germany.						
Denat. Alc..	0.819	1.5	0.5	0.5	....	....
Motor Alc..	0.825	0.75	0.25	0.25	2.0	....
Austria.						
Denat. Alc..	0.835	3.75	0.5	1.25	....	....
Motor Alc..	0.826	0.5	trace	trace	2.5	....
Russia	0.836	10.	0.5	5.	....	....
Italy.						
Motor Alc..	0.835	6.5	0.65	2.0	1.0	....
Switzerland.	0.837	5.	0.32	2.2	....	....

It should be noticed that the formula used in this country differs from any given above, as it contains no pyridine, acetone or benzol, and calls for a higher per cent of methyl alcohol than does the formula of any other country except ing Russia.*

There is a great variance in the estimates of the quantity of industrial alcohol that will be used annually in this country. The wood alcohol interests that opposed the bill in the House asserted that less than 10,000,000 gallons will be consumed, while a few enthusiastic supporters of the measure predict that in a short time the annual consumption will reach 200,000,000 gallons. All such estimates are largely a matter of speculation, but an idea of the amount may be obtained by considering more particularly the use of industrial alcohol. Its uses for power, heating and lighting purposes have been mentioned. Alcohol burns with a pale blue flame that is intensely hot. In alcohol lamps for illumination there is a mantle, similar in manufacture and appearance to the mantle in a Welsbach gas lamp, which is heated to incandescence by an alcohol flame. Such lamps give a light equal to gas lamps in brilliancy, and as the products of combustion of pure alcohol are simply carbon dioxide and water, they are more sanitary than lamps which allow gas to escape into the room. In Europe there are many kinds of stoves for heating and cooking purposes that use denatured alcohol as fuel. Recently an alcohol flat-iron has been invented.

About six months ago at the General Electric Company's works in Lynn, a test was made of a Dentz alcohol engine (made in Germany) that was to be coupled to a dynamo and sent to Cuba, where cheap Cuban alcohol—costing about 12 cents per gallon—will be used. Alcohol engines are internal combustion engines and are similar to gasoline engines, the main difference being that compression is carried to a point greater than is possible with gasoline and a different vaporizer or carbureter is used. The results of the experiments with the Dentz engine proved these three things: The combustion is clearer with alcohol than with gasoline; alcohol is suitable for use in motors even when it contains 15 per cent water; and although a gallon of alcohol has fewer heat units than a gallon of gasoline, it develops about the same amount of power, because it can be compressed more without danger of premature explosion and less heat is lost in the exhaust gases and the heating of the water jacket. Most authorities agree that the efficiency of alcohol engines is probably greater than that of engines using any other fuel for internal combustion. There may be some room for improvement also in this respect because of the newness of alcohol engines.

Thus we see that alcohol is entirely suitable for use in engines, whether or not it will be generally substituted for gasoline depending mainly on the relative prices of alcohol and gasoline. The supply of gasoline is controlled by a trust. Should trust prices be forced to a certain point which is not far above the price of gasoline today, alcohol could profitably compete with gasoline. This phase of potential competition should have a checking influence on the price of gasoline; thus whether or not alcohol displaces gasoline as engine fuel, the general public is benefited in one more way by the passage of the Denatured Alcohol Bill. Gasoline sells at retail for 50 cents per gallon at Goldfield and Tonopah, Nevada, and the price in most of the States west of the Missouri River and north of Texas is between 19 and 25 cents per gallon. Since denatured alcohol can be produced in many of those States for 12 or 15 cents per gallon, because they are extensive producers of corn, sugar or other vegetable products suitable for the cheap manufacture of alcohol, it is not unreasonable to suppose that gasoline may in many localities be displaced by our new industrial agent.

Even at a slight increase in cost, there are reasons why alcohol would be preferred to gasoline as an engine fuel. The exhaust gases of kerosene or gasoline are objectionable because of their odor. The exhaust from alcohol is neither smoky nor evil smelling. A rich mixture of gasoline and air gives a smoky, bad smelling exhaust, while the alcohol exhaust is not disagreeable even when there is a considerable excess of vaporized alcohol for air. This property of alcohol is of some importance when there are good sized stationary engines running a number of hours consecutively and exhausting into a populous neighborhood. The use of alcohol as a fuel is safer because it is not inflammable and an alcohol fire can be extinguished by water. As gasoline floats on water and does not mix with it, water is not effective in putting out gasoline conflagrations. There are numerous restrictions imposed by insurance companies on the storage and use of gasoline. The conditions imposed on the storage and handling of alcohol are less strict and the cost of insurance is lower. These considerations have caused alcohol to displace gasoline in some European localities where alcohol costs a cent or two more per gallon.

In conclusion, let us glance at a list of a few commodities in the manufacture of which alcohol is used. The complete list would be a large one, comprising upwards of 100 articles. It was stated above that the making of coal tar and aniline dyes in this country will be stimulated by the use of denatured alcohol. The introduction of the tax-free industrial alcohol will bring a new industry here, the manufacture of artificial silk from cotton by a process now in use in France. The representatives of a French company so large that its plant uses 6000 gallons of alcohol daily in producing artificial silk stated before a committee of the House of Representatives, when that body was considering the Denatured Alcohol Bill, that if the bill became a law their company would establish a factory in this country. Their experience had shown them that America offered the greatest market for their silk. With cheap cotton, cheap alcohol, and a large demand for the silk, this new industry will probably become an important one.

Denatured alcohol is also used in the manufacture of smokeless powder, hats, shellac, varnish, celluloid, furniture, paints, electrical apparatus, transparent soaps, picture mouldings, and in the curing of tobacco. In the past the high tax on grain alcohol forced manufacturers to use wood alcohol to the extent of 7,500,000 gallons annually in making some of these articles. But as wood alcohol sufficiently pure for this purpose costs about 70 cents per gallon, there is no doubt but that denatured alcohol will entirely displace it. This results in a saving to manufacturers, and in some cases will lower the cost of the articles to consumers. This, however, is not the greatest advantage of this substitution of solvents. There have been a number of well authenticated cases of wood alcohol poisoning—even loss of eye-sight—due to the continued inhalation and absorption of this poison by persons employed in factories where wood alcohol is used. Suffering, therefore, will also be prevented by the use of denatured alcohol in the arts and industries.

*For a comprehensive digest of the portions of the Denatured Alcohol Law of interest to distillers and to proprietors of denaturing plants see "Scientific American Supplements," Vol. 62, pages 25754, 25758-9, 25778-9.

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EDITORIAL.

Illumination

In no field of physical science are the standards and methods of measurement so unsatisfactory as in the realm of lighting and illumination. The unit of light, the candle power, is most misleading. This is largely due to the fact that under almost all conditions it is not only light that is wanted, but illumination.

When any form of lighting has its magnitude expressed in candle power, many important factors are left out. With the candle power a certain definite amount, the color of the light may increase the efficiency of the source of light as an illuminant enormously. The converse is equally true that with a constant candle power some other color of light may decrease its utility to an equal degree. The color of light is of importance, yet there are other features which must be given even greater consideration. For a number of years it has been recognized that rarely is a certain amount of lighting required, but rather a satisfactory degree of illumination. The color of the walls and ceilings of a room will have as much to do with the proper lighting and its distribution as the character of the lights themselves, their location and the quality of light available.

Any one who has worked in a photometer room is familiar with the effect of a single source of light in a space absolutely dark, there being no reflection of light from surrounding objects. When a lighted candle is taken into a dark tunnel, the walls of which are very dark or even black, the same effect is produced. When one is near the candle light it seems that the darkness is so intense that the light does not penetrate it except very slightly. The same candle in a room with absolutely white walls, with curved ceilings and no corners or openings, will produce a degree of illumination which is a surprise to the one experiencing these two very elementary experiments.

It is therefore obvious that the decorations and arrangements of ceilings or shape of the reflecting walls and the color of the furnishings of the room must all be given as careful treatment as the distribution and number of lights.

In the early days of the constant current open arc lamp, the amount of light from the 10 ampere arc was supposed to be 2000 candle power. The actual number of watts for each arc was approximately 450. This gives an efficiency of light expressed in candle power per watt far above that of any other form of light which may be produced by the electric current. It was soon found, however, that in reality the 10 ampere arc does not give 2000 candle power with a consumption of 450 watts; that while the light emitted from the crater of the upper carbon is exceedingly intense, yet over the entire lower hemisphere the light from the direct current open arc is not uniform, and lucky indeed is the man who can find from such a direct current open arc 2000 candle power in any part of the field illuminated. The introduction of the enclosed arc lamp, both direct and alternating current was seemingly a step backward in the efficiency of the lamp as expressed in watts per candle power. As an illuminant, however, due largely to the fact that the source of light was enlarged from a mere point to a comparatively large surface, the enclosed arc lamp was found to be better for general illumination than the open direct current arc.

A single filament incandescent lamp of the old style with the filament in the shape of a hair-pin is open to the same objections, but to a less extent, as the open arc lamp. A very decided improvement resulted in increasing the luminous surface of the filament of the incandescent lamp by the use of a coil of one or more turn in place of the U-shaped filament. It must, however, be admitted that the incandescent lamp, notwithstanding its wide application for lighting and illumination, is not as satisfactory as some other sources of light.

The flat open gas jet with its flickering, due to currents of air, even when surrounded by globes, is of course very unsatisfactory. The amount of heat given off from such open jets is an additional source of annoyance and inconvenience. The forms and types of gas lamps which are in use today, however, are much superior to the incandescent lamp in color and in the magnitude of the illuminating surface which constitutes the source of light. An incandescent lamp will flicker unless the voltage supplied to the terminals of the lamp is absolutely uniform. The diffi-

culty involved in maintaining the voltage sufficiently constant when current for both light and power is required, is increased enormously as the size of the systems of transmission and distribution are increased.

For certain uses, such as reading or microscopical work where the eye is necessarily concentrated on a small surface, the coal oil lamp with suitable shade cannot be excelled by either gas or electricity.

A most interesting field, as yet commercially undeveloped, lies in the illumination of rooms, stores and galleries with vacuum tubes in which electrical discharges at high voltages are taking place. The absence of heat, the exceedingly satisfactory color of the light and the large surface constituting the source of light, all tend to make the illumination from such tubes exceedingly satisfactory. With a considerable number of tubes properly operated the variation in the magnitude of the light emitted is exceedingly small.

While it is probably not the engineers' field of operation, yet a proper consideration of the distribution of light as well as the color of the walls and surroundings should always be given by those interested in the progress and development of lighting from any source, no matter whether arc lamps, incandescent lamps, luminous tubes or gas burners of any type may be in service.

ORDER OF REJUVENATED SONS OF JOVE.

A number of gentlemen interested in the various branches of the electrical trade met at an informal lunch on April 6th, 1907, at Solari's Cafe, San Francisco, for the purpose of organizing a chapter of the Order of the Sons of Jove.

Mr. George A. Cole, No. 533, Jovian Statesman of California, presided at the meeting.

After the organization had been perfected, the following officers were elected for the ensuing year:

W. Martland, Jupiter; C. E. Wiggins, Mercury; R. S. Phelps, Vulcan; C. C. Hillis, Pluto; E. B. Strong, Neptune; A. E. Drendell, Mars; J. F. Hetty, Hercules; S. H. Taylor, Apollo.

After arranging for a rejuvenation at the Cliff House on Tuesday evening, April 9th, the meeting adjourned.

S. O. J. Rejuvenation.

Twenty-eight jolly Jovians met in conclave on April 9th, 1907, on the banks of Neptune's domain, the Cliff House, San Francisco, where ten candidates awaited their fate at the hands of Jupiter. We are proud to say there were none found with "short circuits," so that the emergency "cut-outs" were not necessary.

After a most sumptuous repast in which not the least enjoyable feature was the singing of the Jovian quartet, the banquet room was cleared for the ceremony. The following Tallow Dips were raised to Arc Lights that night:

F. E. Corwin, E. E. Elliott, W. L. Goodwin, Karl Woernecke, Chas. Brown, Frank Fowden, C. E. Winchell, W. R. Green, G. A. Young and Chas. M. Wood.

It fell to the lot of Messrs. Woernecke, Winchell, Green and Wood to do the Jovian honors, and right royally they succeeded. Pluto, for the nonce, reigned supreme. But when the sound of the gavel from Jupiter's realm, at eleven o'clock, rang the curtain down, and Pluto was relegated to his fiery furnace, there to remain until such times as other worthy Tallow Dips shall apply for admission into the Order, and his services needed again, the ceremonies were closed.

If the sentiments of good-fellowship expressed by the many that were present that evening is any criterion, the "Journal" predicts that the Order of the Sons of Jove will soon become one of the strongest organizations on the Pacific Coast. And we take the liberty of advising all good and true electrical advocates to join the Order at their earliest opportunity.

The permanent headquarters of the Sons of Jove have not as yet been decided upon, but they expect soon to have their own club rooms.

The charter members are as follows: A. E. Rowe, A. St. J. Bowie, F. H. Poss, J. A. Vandegrift, A. E. Skillicorn, H. C. Baker, C. E. Wiggins, A. M. Funcke, A. E. Drendell, C. McColgan, S. H. Taylor, E. B. Strong, H. C. Thaxter, J. F. Hetty, H. A. Sayles, W. R. Dunbar, J. R. Cole, J. H. McClellan, C. C. Hillis, W. I. Otis, T. E. Bibbins, R. W. Martland, R. S. Phelps, G. A. Cole, H. B. Carter and E. N. Fobes.

N. E. C. ASSOCIATION ANNUAL CONVENTION.

The seventh annual convention of the National Electrical Contractors' Association of the United States will be held in New York City, July 17th, 18th and 19th, inclusive.

Even at this early date all indications point to this convention being the most largely attended and probably the most interesting and entertaining in the history of the association.

BOOK REVIEWS.

Engineering Series of the University of Wisconsin, Bulletin No. 145, "An Investigation of the Borides and the Silicides," by Oliver Patterson Watts, Ph. D.

This paper presents the results of an experimental investigation of some of the compounds of the borides and the silicides which have become of scientific and commercial importance since the advent of the electirc furnace.

Bulletin No. 148 of the same series is the published results of a series of tests on "Reinforced Concrete," by Ernest Anthony Moritz, C. E.

In addition to the general observations on the action of reinforced concrete beams under stress, separate discussion is given to such particular phases of the subject as: The early appearance of minute cracks on the tension side of the beams; position of the neutral axis; efficiency of the different methods of reinforcing in preventing inclined tension failures; tests on sixteen 8x11-inch by 13-foot beams.

TRADE CATALOGUES.

The Allis-Chalmers Company has adopted the plan of issuing miniature bulletins (in addition to their regular publications) which are designed as envelope enclosures. This prohibits giving much detail of description regarding the various subjects; nevertheless, the reading of them will be sufficient to stimulate interest in the subject.

The H. W. Johns Manville Company is sending out a small folder descriptive of a new electric heater which it manufactures. It is convenient and inexpensive and furthermore has the approval of the National Board of Fire Underwriters.

AN AMERICAN DECORATION.

At the meeting of the Executive Committee of the American Institute of Social Service held this week at the Players' Club as the guests of Mr. Richard Watson Gilder, announcement was made that the Scientific American, through a desire to co-operate with the work of the institute in promoting an American Museum of Safety Devices, would give annually a gold medal to be awarded by the institute for the best device for safeguarding life and limb.

An advisory committee of the editors of the great technical papers was organized to co-operate with the institute in the work of protecting life and limb.

The Exposition of Safety Devices which was held by the institute in New York last month has been forwarded from the exposition at Chicago, where it was loaned for one week, to Boston for their exposition during the second week in April.

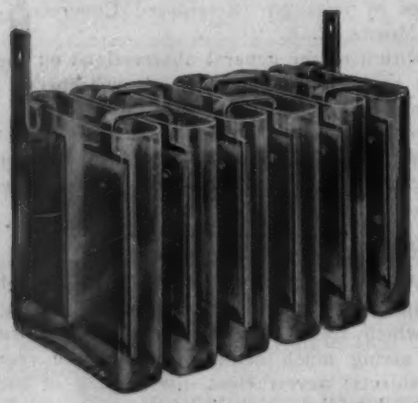
INDUSTRIAL

A NEW COUPLE TYPE STORAGE BATTERY.

In operating fire alarm and police signal telegraphs, private branch telephone exchanges and railroad signal systems only small amounts of current are required, but these are used on a closed circuit and absolute reliability of operation overrides all other considerations. Closed circuit work prescribes a low rate of discharge and freedom from polarization. As there is no primary cell of reasonable cost which is not seriously choked by polarization after standing on closed circuit for a few hours, this fact alone would cause storage batteries to be greatly preferred for such work. Furthermore, the experience of many years has demonstrated that the storage of secondary battery is superior to gravity and other forms of primary cells in requiring hardly more than one-third of the space for equal amperage, in freedom from the formation and creeping of salts in the jars, in requiring far less cleaning and attendance, in materially reducing the cost of maintenance and renewals of parts and in having a lower internal resistance as well as far more uniform voltage.

For the particular work of fire alarm telegraphs and similar installations, the most advantageous form of storage cell has been found in the "couple" type, which has no more than one pair of plates in each cell, as but small ampere capacity is needed while a low rate of discharge, accessibility of parts, and especially absolute certainty of action are essential.

Hitherto separators of insulating material have been



GOULD "TANDEM" COUPLE TYPE CELLS

placed between adjacent plates in all couple types of storage batteries, excepting those in which the plates are covered with hard rubber or celluloid envelopes, which practically act as separators. Though they are kept as thin as may be consistent with their office of preventing short circuits between plates, and though they are plentifully perforated, these separators necessarily obstruct free circulation of the electrolyte, which is of the utmost importance to the maintenance of voltage. This objection is inseparable from the types of cells in which plates are placed face to face in order to concentrate great capacity in a small space. In many types of these cells electrolytic action takes place at varying rates, in different parts of the same grid, producing local distortion, which causes the active material to drop out as sediment and necessarily shortens the life of the plate.

Necessarily, the action between the positive and negative sides which face each other is far more intense than between the sides turned away from each other, so that charge and discharge take place mainly on the facing sides, producing a tendency to buckle and wear unevenly. All these defects are completely eliminated by placing the plates edge to edge instead of face to face, as shown in the new Gould "tandem" couple type here illustrated.

As all parts of both sides of both plates are exposed to exactly the same conditions of acid-supply and exposure to the electrolyte, charge and discharge proceed at the same rate in every part of the grid, which, owing to its peculiar "spun" construction out of hard rolled integral lead and its proportions of reserve lead base to active material, will retain its original capacity and shape intact for many years, no part giving way until the whole plate all over gives out by complete consumption.

The positive plate of each cell is permanently joined to the negative plate of its neighbor by broad, thick, substantial curved lead bonds, "burned" to the plates, so that no bolts are used except at the end of each row of cells. This permanent connection saves considerable time and trouble in assembling the battery, enables the plates to be quickly lifted out for inspection as well as for cleaning of the cell and avoids corrosion of bolted connections by sulphurie acid fumes, besides having practically negligable ohmic resistance. This construction presents many advantages, such as low internal resistance, perfect permanent connections, convenience and simplicity in handling, low first cost, accessibility for inspection, and, above all, absolute reliability of operation for use on fire alarm and police telegraphs.

It may be of interest that the fire department of one of the largest cities in this country has recently installed several batteries of these tandem couples and reports unusually satisfactory results. The Gould Storage Battery Company has on the press a very instructive booklet on "Couple Types of Storage Batteries," copies of which will be furnished to anyone interested.

To supply current for fire alarm and police signal telegraphs, railroad signal and similar systems, modern practice usually provides duplicate storage batteries for each separate circuit, so that one battery may be charged while the other supplies current for the circuit. This arrangement possesses the further advantage of keeping one battery in readiness at all times in case of accident to the companion battery, with sufficient capacity to allow a delay of sixty hours for repairs without serious inconvenience.

TWO BIG ALLIS-CHALMERS DIRECT CURRENT GENERATORS FOR THE BOSTON ELEVATED RAILWAY.

The Stone & Webster Engineering Corporation of Boston, prominent consulting and operating engineers, acting for the Boston Elevated Railway, recently placed contracts for two large Allis-Chalmers direct current railway generators, which rival in size and capacity any machines of a similar type in the country.

These machines, which are to be installed in the new extension to the Boston Elevated Railway Company's Lincoln Wharf station, on Atlantic Avenue, are to have a capacity of 2700 Kilowatts, 600 volts, and operate at a speed of 75 revolutions per minute. In this station is generated the larger portion of the current used for operating the elevated railway division and the cars through the East Boston tunnel.

The generators, which will be driven by vertical cross compound engines, will have armatures of such diameter that

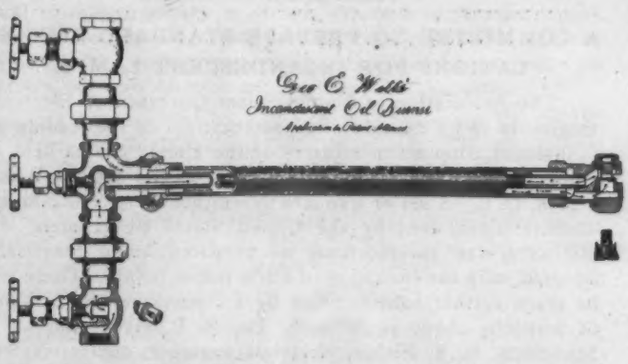
they will have to be built up on the ground. Each machine will have 32 poles; will have no band wires on the armature, and will be equipped with the Allis-Chalmers patented brush oscillating device, by means of which the brushes travel back and forth on the commutator in a direction parallel with the engine shaft, thus keeping the commutator in perfect condition and avoiding the usual wearing grooves.

FUEL OIL BURNERS.

The shortage of coal on the Pacific Coast during the past few months has given an added impetus to the use of crude oil for the generation of steam, although this kind of fuel had already replaced coal in the majority of plants in California.

The successful use of crude oil depends very largely on the type of burner installed. The "Little Giant" and "Incandescent" burners, manufactured by the George E. Witt Company, 530 Mission Street, San Francisco, have proven admirably efficient and reliable, and are entensively used by railroad and power companies and manufacturers. The "Little Giant" burner permits a ready adjustment for wide variations in load, produces a mild flame and is capable of close and delicate regulation. This type of burner is used to a large extent on the ferryboats of the Southern Pacific and North Shore railroads as well as on the locomotives and in the stationary plants of these and other Western roads.

The "Incandescent" burner includes two types. One of these is especially suitable for low oil pressures. The atomizer is of steel and interchangeable, and is fitted with a



ground joint which facilitates the separation of the steam and oil. The mixing partly takes place between the lips of the outer casing, thus preventing carbonization.

The other type of "Incandescent" burner is suitable for small vertical and horizontal boilers, for threshing machines, and where an oil pump is not used. It is a gravity burner and will operate on one pound of oil pressure.

A locomotive burner is also made by the George E. Witt Company which has the following features: The atomizer is interchangeable and can be adjusted to throw the flame in any direction. The atomizer is provided with three passages for the influx of the oil which cause it to spread evenly over the steam jet. The steam produces a partial vacuum on the oil, which is a great advantage where no oil pressure is employed.

This company has also devised a system of burning crude oil under low pressure for hot water heating systems, and also a noiseless retort furnace, which, it is claimed, will enable the boiler to hold steam for 48 hours after the furnace is thoroughly heated. Such a furnace obviously eliminates the use of a small auxiliary steam boiler for starting up the plant.

FORMAL OPENING OF THE NEW POWER PLANT AT CAZADERO.

The completion and throwing open to operation of the Portland Railway, Light and Power Company's new generating plant at Cazadero on February 26th was an event of not only absorbing local importance, but one of far-reaching interest to the State at large. That it was recognized as a notable event and one of wide interest is shown by the presence at the opening ceremonies of prominent State and City officials and of many distinguished private citizens.

When Mayor Lane, of Portland, in the presence of the president and officers of the Portland Railway, Light and Power Company, the engineers whose patient labors brought about the successful completion of the new plant, and the assemblage of distinguished guests, turned the switch which set in motion the great wheels in the power-house at Cazadero, that moment marked an eventful advance for the City of Portland. It meant that Portland's supply of electric power was more than doubled. It meant the completion of more than three years' labor and the expenditure of more than $1,000,000. It meant that the Portland Railway, Light and Power Company, following the broad-gauge policy advocated by its president and owners, and with unshaken faith in the ultimate supremacy of Portland as the commercial center of the Pacific Northwest, had backed its belief by the expenditure of this great sum to provide the company's customers with a service as nearly perfect as possible, and to make adequate provision for its rapidly increasing business, and the fast and continuous development of this city as a residential, mercantile, manufacturing and commercial center.

This power station, which is the largest electrical plant in the State of Oregon, is situated thirty-eight miles from the City of Portland, on the Clackamas river, and has a present output of 15,000 horsepower, which will be increased shortly to 25,000 horsepower, with the addition of two more generating units as originally planned.

About a mile above the power-house is the dam proper, which is 176 feet wide and 130 feet long at the base, and whose total length at the top is 400 feet. Here the water is taken from the Clackamas river through a bulkhead 17 feet by 25 feet and into a flume 2,622 feet long. This flume, which follows the contour of the hillside, discharges into a canal 2,898 feet long, 35 feet wide at the bottom, 20 feet deep and 75 feet wide at the top, which in turn empties into the main reservoir or lake.

The reservoir, which covers 50 acres when filled to an average depth of 20 feet, has a capacity of 326,480,000 gallons. When filled to this level the reservoir will supply power sufficient to run the wheels of the power plant below for six hours after the gates at the dam have been closed.

The forebay gates are located at the lower end of the reservoir and set in massive concrete walls built on the top edge of the river bluff. This wall, of steel and concrete construction, is 8 feet thick at the top and 20 feet thick at the bottom, built on foundations of sandstone bedrock. The water is led from the forebay gates to the power-house 138 feet below in tubes 8 feet in diameter, inclined at an angle of 45 degrees and lying along the hillside.

The power-house is of concrete construction 180 feet long by 54 feet wide, and in it is installed the necessary apparatus to double the supply of electrical energy to the City of Portland. The equipment is composed of three double 42-inch hydraulic turbine wheels of the Frances ype, to which are directly connected three Allis-Chalmers generators.

The three alternators are of the standard two-bearing water-wheel type with horizontal shaft. They have a normal rated output of 2500 kilowatts each, at a terminal pressure of 11,000 volts, three-phase. The revolving field has 12 poles and the speed is 330 revolutions per minute, thus giving a frequency of thirty-three cycles per second. Each alternator is equipped with a direct connected exciter, the armature of which is mounted on the end of the alternator shaft; the exciter field yoke is carried on an extension of the bed of the alternator. Bearings are of the ring oiling self-aligning type, water jacketed.

The stator yoke is of unusually stiff construction, being provided with heavy end heads, which serve to clamp the

laminations and at the same time reinforce the main part of the yoke. The laminations are of specially selected steel carefully varnished and assembled. The core is provided with numerous ventilating ducts, through which a strong blast of air is forced by the revolving field; the ventilation in these machines is exceptionally good, because of the high peripheral speed of the rotating part. The starting coils are very carefully insulated to withstand the high pressure for which these machines are wound, and they are placed in open slots; coils can thus be easily replaced in case of damage. The coils are securely held in the slots by means of wedges, and the end portions projecting beyond the core are so fastened that they cannot become displaced by abnormally large currents.

Because of the high peripheral speed, it is necessary to make the rotating part exceptionally strong. The spider is of cast steel, supporting a rim made up of steel laminations dovetailed to the spider arms and securely clamped between heavy cast steel end heads. The field poles are built up of steel laminations in the usual manner and are dovetailed to the laminated rim, being held in place by tapered keys. The field winding is of copper strip bent on edge and is designed for 120 volt exitation. Current is supplied to the field through cast copper collector rings and carbon brushes, the latter being held in brush holders supported from a suitable stand.

Tests on these machines showed that they were capable of carrying full load continuously with a rise in temperature less than 35 degrees centigrade, thus giving them a liberal margin for overloads.

With the completion of the water-power plant at Cazadero of 15,000 horsepower capacity, and with the plant at Oregon City, developing 12,000 horsepower and the steam plant in North Portland, 11,000 horsepower, the company now has available nearly 40,000 horsepower of electrical energy.

Inasmuch as the entire light and power load in Portland and vicinity, at the present time, is not more than 25,000 horsepower, there is about 15,000 horsepower of machinery in the Company's generating plants, to be held as reserve, in cases of emergency.

Almost the entire output of these generating plants is conducted by means of special tie lines to two principal sub-stations, one at Seventh and Alder Streets, on the West Side, and one at Knott Street and Williams Avenue, on the East Side. From these two sub-stations as distributing points, this power is carried by innumerable small feeders to various parts of the city and suburbs, for serving its customers with light and power, and operating the many street railway lines.

In addition to the above mentioned principal sub-stations, power is also distributed from sub-stations at Eagle Creek, Boring, Gresham, Lents Junction, Sellwood, East First and Harrison Streets and at St. Johns.

In order to prevent interruption upon its system, and therefore to insure continuity of service to its customers, it is necessary not only to have reserve machinery, in the generating stations, but also to have a duplication of transmission lines from these stations to the sub-stations, and between sub-stations, so that in case of the breaking of any one line, a reserve can be immediately placed in commission, and therefore the interruption to service, if any, would be but momentary.

With this idea in view the company has about completed the installation of such a duplicate system. From the plant at Cazadero, two separate and distinct transmission lines, by different routes, have been constructed, terminating at the sub-station at Williams Avenue and Knott Street. Similarly, from the plant at Oregon City, there are three separate lines to Portland, one on the East Side to the East Side station, and two on the West Side, to the West Side station.

This duplicate system of conducting lines has been installed also between the steam plant in North Portland and the sub-station at Seventh and Alder Streets, and between the East Side and West Side sub-stations. By such a duplicate system of connecting lines and with 15,000 horsepower of reserve machinery in the power-houses, the possibility of interruption to service upon the system is extremely small, for in case of serious trouble in any one station, or in case of interruption of any connecting line, there is always sufficient available reserve capacity, and always duplicate routes, by which the various distributing points may be served.

A second power plant, duplicating the Cazadero plant, is planned by the company and will be erected on the Upper Clackamas river, two and one-half miles above the new plant just opened at Cazadero. Work has been commenced clearing the ground and surveying for the new plant. The operations will be continued steadily and the company plans to have the new dam and station completed in about four years, at the end of which time the Cazadero plant will probably be used to capacity.

The station to be erected above Cazadero will develop 25,000 horsepower. These two plants on the Upper Clackamas will generate 50,000 horsepower, which, probably, with the resources already at the command of the company, will take care of every requirement of Portland for light and power for the next ten years.

A splendid water power is available in the Clackamas river two and one-half miles above Cazadero. Conditions are somewhat different than those prevailing at the power station just completed, and the dam to be built to develop the power at the upper station will be higher than the one on the river at Cazadero. A fall of 125 feet will be obtained, thus giving tremendous facilities for the generation of power. It is estimated that the new plant will cost about $750,000.

A COMMITTEE TO PREPARE STANDARD SPECIFICATIONS FOR INCANDESCENT LAMPS.

The Association of United States Government Electrical Engineers and a number of representatives of the leading incandescent lamp manufacturers of the United States held an unofficial meeting on February 25th, 26th and 27th at Washington, D. C. A set of standard specifications covering incandescent lamps used by the United States Government was discussed, the specifications as prepared being practically adopted, with the exception of a few minor points. These will be given further consideration by a committee, the make-up of which is about as follows: Dr. E. P. Hyde, Bureau of Standards; B. F. Fisher, electrical engineer, quartermaster's office; J. E. Woodwell, electrical engineer, Treasury Department; W. Y. Avery, Bureau of Equipment, Navy Department; P. L. Dougherty, electrical engineer, Treasury Department; W. C. Allen, electrical engineer, District of Columbia; S. E. Doane, National Electric Lamp Association; Jonathan Camp, Franklin Electric Manufacturing Company; F. W. Willcox, General Electric Company; Walter Cary, Sawyer-Man Electric Company; Edward Campbell, Germania Electric Lamp Company; R. W. Morgan, Anchor Lamp Company, and Preston S. Millar, Electrical Testing Laboratories, New York City.

ELECTRICAL DEVELOPMENT IN SOUTH AMERICA.

What is recognized as a signal victory in the development of South America is the fact that the government of Brazil has just granted permission to Messrs. Guinle & Company of Rio de Janeiro to sell electricity in the capitol city as well as other important cities in the republic. The contracts for light and power in Nictheroy and other cities along the proposed transmission lines have already been let.

The initial electric power sources will include several hydro-electric stations just being completed on various waterfalls controlled by Guinle & Company. These have an aggregate capacity of some 50,000 horsepower. The electrical equipment was furnished by the General Electric Company of New York. It is expected that work on the transmission lines will be started next June.

NEWS NOTES

FINANCIAL.

San Francisco, Cal.—The annual meeting of the Geary Street, Park and Ocean R. R. will take place at 1 p. m., April 10, at 1592 Geary Street.

Hanford, Cal.—The Niagara Oil Co. has declared an assessment of twelve cents per share, delinquent April 20, sale day May 10.

Richmond, Cal.—There will be a meeting of the stockholders of the Great Western Power Co. April 2, in the Bank of Richmond, here.

San Francisco, Cal.—An assessment of $2.50 per share, delinquent April 25, sale day May 15, has been declared by the Keystone Oil Co.

San Francisco, Cal.—On April 10 will be held the annual meeting of the stockholders of the South San Francisco Railroad and Power Co., at the Northeast corner of Oak and Broderick Streets.

Los Angeles, Cal.—Governor Gillett has signed the bill, introduced by Assemblyman Phil A. Stanton of this place, which is an enabling act to permit Los Angeles to issue bonds for the construction of the Owens River municipal system. The bill provides that bonds may be issued serially so that they may be sold in amounts of $5,000,000 each. Another bill provides that the Board of Public Works in carrying out the construction work may either let contracts for certain portions of it or go ahead and do the work.

Los Angeles, Cal.—Senator Geo. S. Nixon, of Nevada, H. G. Hayes, of Goldfield, and Geo. Wingfield, of Goldfield, constitute the purchasers of the People's Gas Company. They have placed orders in Pittsburg and other steel centers for immense shipments of steel mains, and are planning to increase the capacity of the plant as rapidly as the material can be obtained. Attorney W. M. Goodwin is the local representative of the purchasers of the Lowe Gas Co.

Newport, Cal.—Horace Slater has been in New York raising subscriptions for the installation of a gas plant, estimated to cost $22,000. Of this amount $11,000 is to be raised by subscription and the remainder will be taken by Mr. Slater, R. J. Dunn and C. A. Watson, of Redlands. The company is to be incorporated with a capital stock of $75,000, $25,000 of which is to be paid up.

San Francisco, Cal.—The San Francisco Coke and Gas Co. will hereafter be known as tthe Metropolitan Light and Power Co. With the change of name the concern has increased its bonded indebtedness from $2,500,000 to $7,500,000. At a meeting of the stockholders, held last week, the directors of the company were authorized to make the increase. President Leopold Michels has said that the increase was for the purpose of allowing an extension of the company's mains, adding to the gas plant, and installing a plant to manufacture and furnish electricity throughout San Francisco.

Redding, Cal.—An action has been brought by nineteen of the farmers living along Old Cow Creek to prevent the Northern Light and Power Co. from using the water of the creek for power purposes. The defendants claim riparian ownership of the stream. They desire to use 2,700 inches of water, which, it is alleged, are more than the stream affords in the dry season. It is also alleged that the defendants desire to divert the course of the stream, causing it to leave its present channel, which would result in the alfalfa and grain lands bordering the creek becoming unproductive. It is therefore prayed by the plaintiffs that an injunction rest against the Northern Light and Power Co.

TRANSPORTATION.

San Diego, Cal.—The franchise for a railroad on B Street, asked for by E. Bartlett Webster, was recommended favorably by the Street Committee of the City Council at a meeting of that body a week ago.

Redlands, Cal.—The San Bernardino Traction Company expects to extend its line now branching off the Highland line and leading up to the Base Line road, up into the grounds of the Southern California State Hospital at Patton.

Las Vegas, N. M.—It is said that the proposition to extend the electric railway system here to the town of Mora has been taken up again and is likely to be put through. The project was believed to have been killed by the failure of the towns to unite when it was first exploited.

Los Angeles, Cal.—Bids have been advertised for by the Board of Supervisors for a franchise for an electric railroad upon certain highways in the county. Beginning at the intersection of Indiana and Stephenson Avenues adjoining the east boundary of the city, the road is to run along Indiana Avenue to the intersection of Fifth Avenue.

Sonora, Cal.—The County Supervisors received last week bids for the franchise for an electric railway from the Stanislaus County line across the mountains, via Sonora Pass into Mono County, with numerous branches throughout this country, the same to be built over the public roads. A. H. Kleinecke, who applied for the franchise, opened negotiations by putting in his bid for $100. Chas. H. Segerstrom raised the bid to $150. Kleinecke bid $375, and was awarded the franchise.

Kennett, Cal.—As soon as the rains cease grading will begin for the extension of the Hoit & Gregg electric road from the upper terminus at the lime kiln to the Golinsky Mine. The present road is about two miles long, and is used to convey limestone ore from the quarry to this place, where is is consumed in the smelter and also shipped to different points on the Coast. The road is now transporting about 300 tons daily, but contracts recently closed will call for an increase to 500 tons.

Berkeley, Cal.—At a special meeting of the Town Trustees last week the Key Route was granted the privilege of laying double tracks inside the town limits on Claremont Avenue. The property owners of the district asked that the Trustees grant a franchise for a single track only, maintaining that a double track would ruin the street for business purposes. In overruling the property owners the City Fathers obtained a concession from the company in the shape of a promise to establish a station on the avenue within the city limits. The new line extends on Claremont Avenue from Fifty-fourth Street, Oakland, to the Claremont Hotel.

WATERWORKS.

Tucson, Ariz.—Bonds have been voted for improvements to the water system and fire department. The sum of $25,000 is to be devoted to the water department, providing Congress gives permission.

Goldfield, Nev.—S. S. Johnson has just returned from a trip to Skiddoo, where he reports very promising prospects. He states that twenty-four miles of pipe are being put in to bring water from the Telescope Mountains to the town.

Madera, Cal.—F. W. Krogh, of the Madera Water Company, states that the plant will soon be improved. An elec-

tric pump with double the capacity of the present pumps is to be installed. The mains will be taken up and larger pipes laid. The system will be extended and made more complete.

Phoenix, Ariz.—A bill authorizing the purchase of the plant of the Phoenix Water Company by the city has been passed, and the question will be put to the voters at the next municipal election. Bonds have already been voted for the construction of a new system, but it is believed that the citizens will prefer to acquire the old plant.

Los Angeles, Cal.—The Ross Oscillating Pump Company, incorporated with a capital of $1,000,000, will soon begin operations. The factory is to manufacture a pump so constructed that the amount of liquid to be moved is governed by the speed at which the pump is run. It can be operated with any kind of power. Andrew J. Ross is president and general manager.

Long Beach, Cal.—Improvements in the water system, to cost approximately $25,000, are to be made by the directors for the Long Beach Water Company within the next few months. Additional machinery will be installed and that now in place will be remodeled. The greater part of the improvements will be at the wells and the pumping plant. A reservoir on the northwest side of Signal Hill will be built with 10,000,000 capacity. Extensive improvements in the piping system will also be made.

Santa Cruz, Cal.—The new Casino and Cottage City Fire System will be connected to the city waterworks by a six-inch main. For reserve supply a four-inch pipe from the Hihn System is to be ready for immediate connection. Attachment is made with the pumping system which is to supply the baths. These pumps are to be located in the new power house, in a specially-constructed fireproof room. From there will extend a sixteen-inch main to the bay.

Berkeley, Cal.—An independent water system is to be installed for the new Claremont Heights tract and the Garber property, Claremont Hotel on the east and the grounds of the State institution for the Deaf and Blind on the south and west. R. R. Paterson, of the Paterson-Smith Company, which is handling the tract, and R. Hughes, consulting engineer of the People's Water Company, inspected the tract and the surrounding property for the purpose of selecting a site for a reservoir. It has not been determined where the water will be secured, whether by tunnels or pipe lines.

Oakland, Cal.—William M. Hatfield has sworn to a complaint in the Superior Court to obtain $5,000 damages from the People's Water Company, successor to the Contra Costa Water Company, and will ask the court to declare the franchise of the corporation forfeited to the municipal corporation of Oakland. It is held that the action is based on the same law and similar condition of affairs that obtained in San Francisco when the franchise of the Spring Valley Water Company was declared to be forfeited. In other words, it is charged that the People's Water Company is collecting rates from the people of Oakland without the warrant of law, the contention of Hatfield being that the rates now charged in Oakland are not authorized by ordinance.

Sacramento, Cal.—As soon as possible steps will be taken to provide a filtration plant for the city water supply that will be capable of delivering 20,000 gallons of pure water every twenty-four hours. To obtain such a plant the City Trustees have authorized City Surveyor Randle to advertise for plans giving the first cost of such a plant by any known method, the cost of operation and maintenance, and the method to be followed: Several propositions looking to the installation of such a plant are in the hands of the Trustees, and as soon as all the plans are in, after the advertising, they will all be considered and the cheapest one adopted. One plan proposed is a series of settling tanks and the use of coagulants, another is a filtration through sand and charcoal, while a third is the settling of the water by running an electric current through it.

ILLUMINATION.

Long Beach, Cal.—A large flow of natural gas has been opened up at the asbestos factory, west of town, and it is thought there will be enough to heat and light the factory.

Pasadena, Cal.—Action in the matter of preventing the city from installing a municipal electric lighting plant has been postponed until April 8. The Edison Electric Company has brought about the litigation.

San Rafael, Cal.—The San Rafael Gas and Electric Company is figuring on running gas mains to San Anselmo, Ross Valley, Kentfield, Larkspur, Corte Madera, Sausalito and Mill Valley. To start the ball rolling the company has let the contract for the erection of a 1,000,000-foot gas holder, to be erected in this city.

Los Angeles, Cal.—An ordinance has been adopted by the City Council declaring intention to order the necessary appliances to be installed for lighting with electricity Ninth Street, between Main and Mill Streets. Ornamental cast-iron lighting posts will be erected at intervals of 110 feet on each side of the street.

San Jacinto, Cal.—The first carload of machinery for the Heret-San Jacinto Gas Company has arrived, and the work of building the plant will go forward at once. T. H. Hess is manager of the works, and is making every effort to expedite the completion of the construction.

Olympia, Wash.—A franchise has been granted to W. S. Dole and associates, of Portland, permitting him to construct a gas plant here for heating, power and light. It is stipulated that the site must be purchased by June 1, 1907, and the plant be in operation by May 1, 1908.

Santa Monica, Cal.—The Los Angeles-Pacific Company has agreed to furnish free electrical energy for arc lamps to be installed along Ocean Avenue, between Montana and Colorado Streets. The company further offers to install, without cost to the city, lamp brackets similar in design to those now in use. The matter will come up before the Trustees at their next meeting.

OIL.

Coalinga, Cal.—Superintendent S. A. Gibeson, of the Associated Oil Company, states that his company will soon install a pumping plant on its property on either section 8 or section 36, and that it will probably move Station 1 to the new location.

San Luis Obispo, Cal.—John W. Baresberg, one of the pioneer oil men of this city, and A. J. Redgan have gone to purchase rigs and the necessary machinery to commence operations of the North Star and the San Luis Obispo Mutual oil companies.

San Luis Obispo, Cal.—Outside of San Luis Obispo and towns in the southern part of the county, Cambria has been the first town in the county to organize an oil company to make arrangements to commence development. Messrs. Webster, Brooks and Nelson have secured a twenty-year lease on the 600-acre ranch owned by Mrs. H. Winteroll. An oil company will be organized and the oil developed.

Los Angeles, Cal.—C. L. Danly, sales agent for the Fulton Oil Company, has notified the Board of Supervisors that he withdraws his offer to furnish the county oil from the Sunset field at twenty-five cents a barrel, free on board, Maricopa. He gives as his reason the inability to secure cars for delivery. It is said that there is more back of this than the simple reason given for withdrawing the offer, and that a combination among oil men may have had its influence in withdrawing the twenty-five-cent quotation.